CHEMICAL & METALLURGICAL ENGINEERING

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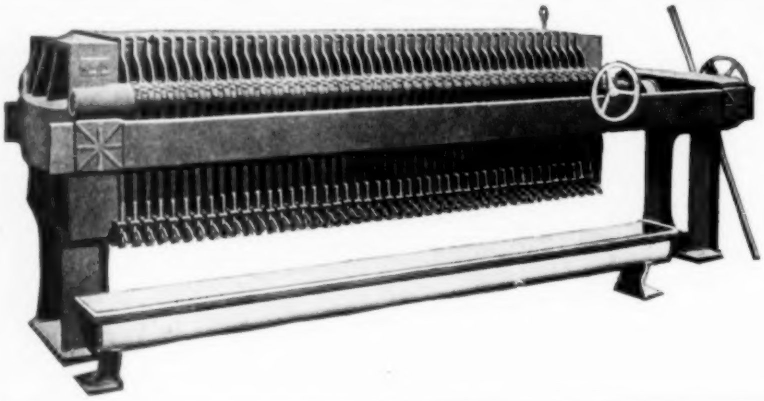

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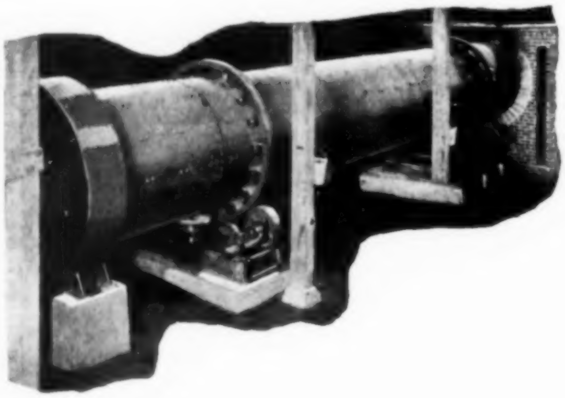

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The Great Cemetery Of Archives

IN A late number of *Science* Prof. HERDMAN F. CLELAND suggests that information about places in the United States which is available in Washington be also made available in the places themselves. The idea is so reasonable that anyone might well blush to say that he didn't think of it before.

Dr. CLELAND, who is a geologist, gives some instances which speak for themselves. At Uvalde, Tex., he observes, there are interesting volcanic necks which are all mapped and described in a United States Geological Survey folio, but when he went there to study the formations there was no folio available or within reach. At Ardmore, Okla., he wished to consult the geological literature of that region, but at the Carnegie Library he found neither the state publications nor the excellent professional paper of the United States Survey of the district. The same holds true of most of the scientific data, obtained at great labor and expense by the Government, of the country and for (it would seem) the records at Washington.

Now there's no use in blaming Washington for this. Society at Uvalde, for instance, or Ardmore, is probably more interested in the beautiful columnar throats described in the best sellers in fiction than it is in volcanic necks, and the librarian of the local storehouse of literature can truthfully say that there isn't any call for books on geology, or botany, or biology.

But why hold Uvalde or Ardmore up to ridicule? Curiosity is a hidden gift in most of us; we have it as little children, then we learn a few things and we bury the gift within us under a wretched, ill-selected bundle of facts which we think we know. The way to arouse curiosity is to stimulate it, and Prof. CLELAND proposes an excellent method. His remedy is:

"That every first-, second- and third-class postoffice be provided with a framed printed list of the federal and state publications which deal with the region in which it is situated, as well as of historical and other publications of local interest. . . . If it became generally known that every postoffice contained such a list of publications the traveler or resident in search of information would immediately go there to consult it."

The second suggestion is "that every postoffice have on sale all the federal and state publications on the exhibited list."

He then gives a delightful example of what might be displayed in his own bally of Williamstown, Mass. It includes topographic maps, a list of three works on local history with notes where the books may be consulted, a memorandum of the publications on the geology, the zoölogy, the botany and the agriculture of the region, with directions where the information may be obtained, and finally a list of collections and objects of local interest.

What an inspiration that would be! Instead of the natural resources of a district being discovered and recorded and then buried in archives and forgotten they would thus become subjects of public knowledge. The simple record of available information in a public place would stimulate industry and arouse minds that are caked to lethargy by the muddy sediment of dull, thoughtless days. Instead of sitting around the stove in the store discussing Judge DOGBERRY's new teeth, or whose dog killed JOHN FERGUSON'S sheep, the neighbors would get a lead not only to talk but to think. It is the road to national enlightenment. The Scotch achieved merit by the discussion of free grace and foreordination, and made of themselves a race of thinkers. If we Americans discuss the resources of the home county we shall learn how to think too. We've been rather shy along that line since the war.

The Value of Short Reports

THE art of stenography, the recording dictagraph, and the typewriting machine are to blame for many troubles. It is a bother and a labor to write longhand, and it is much easier to talk. And a great many of us do talk too much. The troublesome business of long-hand writing and the cost of printing a limited number of reports had the salutary effect in days gone by of inducing us to number our words. Nowadays the busy man gets too much to read. Newspapers are plastered over with useless "Bed Time Stories" and other mush, or news items carried over from a few inches of space on some other page, to provide that advertisements may be "next to reading matter." Nobody wants to learn how little Willie saved a robin's egg, and the inspiring fact that Cordonnier, Schuster & Shoemaker are having a great sale of boots and shoes, all at the same time.

The burden of complaint, however, is with the vast quantity of text that has to be read. Every professional man knows the task of keeping up with his profession, and we admit frankly that it is our business to add to this burden. His daily newspaper is almost a miracle of inconvenience, as far as an orderly presentation of the news of the day is concerned. His daily mail contains as many if not more circulars of tailors, automobile dealers, appeals, etc., which he throws away unread, than it does of actual communications which call for his attention.

The engineer or business man with his technical or trade paper has less to do than the professional man, but if he is a live wire he has still a great deal to read.

Then comes a report on something he wants to know. If he wants an exhaustive treatise he is likely to say so beforehand, but unless he calls for it he doesn't want it. If it is too long he gives a sigh and digs in for a few minutes, and then puts it into his basket of

unfinished business. He takes it home with him at night, and loses patience over having to wade through information that he does not want. Then the chances are that he will turn to the summary and reach his conclusions from that, being a little nettled over the fact that he did not get what he wanted earlier.

When he goes to his lawyer he is not charged for the length of the interview: it may last 15 minutes the first visit, the lawyer may work two weeks over the problem and then telephone the one word "Don't." But his counsel fee will not be nominal.

With no suggestion that reports of research of any kind shall be superficial, we make the plea for conciseness in technical reports whenever this is possible. All details should be duly annexed and speedily available, but the reports themselves should measure up to the novelist's rule: "First catch the reader, and then hold him."

Shuffling the Pack and Dealing a New Hand

PLAYING cards have been personified by the fortune teller ever since they came into vogue centuries ago. It may be stated without hesitation that cartomancy, which is the scientific name of fortune telling with cards, has had and continues to exert a far greater influence on human affairs than the oracles did in pre-Christian times. This was due to the fact that there was but one Delphian and one Dodona, each of which was no more productive of interpretation signs upon which to base plausible stories than a 32-card pack with sevens low. The card pack had distinct advantages over the oracle in that it was portable and was not limited as to number. It was in the manufacture of cards that the printer found the first great outlet for his craft, which was too crude in the early days to merit any monetary return on an art basis. In this contribution alone cards have had a stupendous influence on human affairs.

This is not the place to dwell on the phases of a subject which properly belongs to EDMOND HOYLE, so the rank of hearts and diamonds and the hundreds of other human points involved in cards will not be discussed. We only want to look at an ancient analogy from a new point of view and reverse on seeing humans in cards and see humans in terms of cards. We are already familiar with the Ace in this light, thanks to our aviator friends. During the past year we have witnessed the greatest human shuffle and redeal in the personnel of our industrial companies that has ever been known. We have seen some companies exchange their old cards for better ones and improve their hand. Others have lost very seriously. Some have gambled rather recklessly and let luck take its course.

Satisfaction with any hand all depends whether poker, euchre, whist or bridge is going to be the game in which the hand is to be played. Right and left bowers may top the aces in euchre. A straight flush made up of humble number cards is a hard hand to beat in poker. The idea in general that a hand must be all aces to be high is a false one in personnel as well as in cards. A proper conception of this fact is of vital importance to those concerned with personnel. Men are not labeled with simply read marks like cards and here lies one of the greatest difficulties. Character analysis may and may not be as exact a science as is being openly and publicly claimed at the present time. There is no doubt that some executives are endowed with extraordinary faculties of sizing up men. There are many individuals, however, who are mere quack practitioners. Recently one of the latter variety was called in to reorganize the personnel of a firm, and going up the elevator, he observed that the elevator operator showed financial characteristics. In the course of his examinations, he found the cashier of this firm had mechanical tendencies. So he had the jobs of the two changed. The result was that the following day both cash and new cashier had disappeared. The elevator boy had lifted the cash. And so the human shuffle goes.

Authoritative Opinion On Synthetic Food

A FEW days ago Mr. Ford told a reporter of the New York *Tribune* that the gentle cow is doomed to follow into oblivion that expensive hay motor known as the horse. The chemist, it seems, is about to synthesize milk and cream from grain. We are glad to have the particulars because we might have guessed he would do it from acetylene and air and ammonia. Commenting on Mr. FORD'S assertion, however, a chemist attached to the New York State Dairy Commission declared that the motor manufacturer was in error and that the cow is likely to be with us for some time. Mr. FORD'S opinion on synthetic milk took him far afield from the subject about which he knows most and is best qualified to express an opinion.

Chemists, however, are addressing themselves to the important and pertinent subject of human food, as indicated in recent articles in this magazine by Dr. ALSBERG and Mr. HILTNER. Referring to synthetic food, the latter went so far as to say: "The kitchen is not the normal place for the chemist. The trained appetite will not willingly open its mouth for chemical food. The layman in his mind associates chemicals with poisonous acids and vile smells and wants none of them for food. 'God-made' foods are to be preferred to 'man-made.'"

We are not certain about any of these opinions, expert or inexpert. We have no idea how we should feel or what we should think if we had as many millions as Mr. FORD. Probably it would make us didactic also. If we had the conviction that milk and cream might be synthesized from grain, we should probably instigate research in the matter. Cows are a nuisance, and they are subject to all sorts of disorders. The Dairy Commission chemist is evidently interested in his job, and he is for permanent cows. It seems to us, however, as though some new kind of disease might carry off so many cattle that we should have to find sustenance and comfort (until the days of synthetic milk, if these come) in the more hardy goat. We have had many tender spots from and for goats; and we attribute the experience to the fact that goats are like some men we know in habit, manner and mind.

We lack also Mr. HILTNER'S catholicity; we are not in agreement about all of the "God-made" foods, although, like him, we desire to please the canners because they have sense and engage in research with intelligence and understanding. It seems almost profane to call some natural foods "God-made." And we differ vigorously about the place of the chemist in the kitchen. The kitchen needs the chemist on the ground of economy, and the chemist needs the kitchen to give him a basis of art—the great art of cooking. In the

glorious days of Kingdom Come we expect to see, provided we are equipped with the ghostly eye, the kitchen of every chemist in his dining room and apart from the scullery. The chemist will cook his own dinners, and of all the men in town he will be the one most diligently sought after for his company. The girl that marries the chemist will be in luck, for then she can snub her dearest enemy by not inviting her to dinner. The London aldermen with their turtle soup and their turbot will suffer pangs of jealousy unless they can induce some distinguished chemist to volunteer to cook for them on Lord Mayor's Day. When the chemist enters the kitchen door he will find it *open sesame* to any class of society he desires. We know a chemist who cooks his own dinners, and so far as we are aware he is the most popular man in his home town.

Special Experts: Charwomen and Chemists

IN A long article in the New York *Herald* of Feb. 27 on the 100,000 jobs, more or less, to be filled by President HARDING, there is a note to make chemists blush.

It states that "Government jobs are divided into four general classes: Those filled by the President with Senatorial approval, those filled by the President and one of the executive officials without Senatorial approval, those within the civil service list, and those carried on the rolls because of special fitness for the work to which they are assigned but without regard to the civil service—for example, certain groups of chemists and special experts and charwomen and laborers."

It sounds almost Russian; modern Russian. We heard the other day of a gentleman of Moscow who had formerly held a post of great dignity and requiring special training and fitness. He now serves the Soviet State in a post that requires his special training and fitness but, of course, without the dignity. A place to live is assigned to him and his wife. Early in the morning he goes out, chops wood, brings it in and builds a fire, and his wife, who is delicate, cooks his breakfast. Rations are assigned to him which he brings home after the day's work. Servants are not. They are not allowed. The proletariet rules and it does not serve. Then the old gentleman gets theater tickets as often as it is right and proper for him to be amused. There is no buying or selling or even trading. The Soviet State provides what it holds to be good for everyone.

If this were a Soviet government, of course the priority in the *Herald's* list would have been changed. It would have dealt with charwomen and chemists instead of the other way about. That would provide alphabetical sequence too, and it is possible and even likely that the charwomen outrank the chemists in point of age and length of service.

The whole thing is democratic, but we might as well 'fess up and tell the world that when it comes to training and fitness we think people are different and that they do not grade alike. Between mopping up a floor and the manipulation of delicate apparatus with the necessary thought as to what such apparatus shall do, we think we can see a difference. We do not like the word physicist; we agree with the late Lord KELVIN that the only real physicist is a siphon of soda water. But we haven't a better word at hand to indicate the men who should be classed with chemists rather than charwomen, and perhaps physicists are, in the eyes of government, "special experts."

Successful Chemical Research in Anæsthesia

IN A paper recently presented before the American Oil Chemists Society, Dr. CHARLES BASKERVILLE, head of the department of chemistry of the College of the City of New York, pointed out a new use for edible oils in surgery.

It is well known that the vapors of ether or chloroform, when inhaled, produce the condition known as anæsthesia. This action is contingent upon the drug being taken up by the blood through the capillaries of the lungs. Exclusion of air produces asphyxiation, so that care must be observed to employ the proper mixture of ether with air to provide muscular relaxation and unconsciousness to pain—but no more. The process is a severe tax upon the patient, it chokes him and afterward nauseates him, and he dreads it.

The circulation of the blood takes place through numerous channels around the intestines, the stomach, indeed the whole alimentary tract as well as in the lungs, and numerous unsuccessful efforts have been made to administer ether or chloroform in the lower bowel by means of an enema. But ether boils at 34.6 deg., while the normal body temperature is 37. The lungs proceed to exhale ether almost immediately, but the dose is taken too fast and the subject may be asphyxiated. Little progress was made until Dr. J. T. GWATHMEY of New York conceived the idea of using the solubility of ether in oils and administering such a solution as an enema. Dr. BASKERVILLE has been working in collaboration with Dr. GWATHMEY for several years, and the result is a series of oil-ether solutions with the rates of evaporations determined and controlled. Various vegetable and mineral oils are used. After many experiments with animals the method of oil-ether enema was applied to persons and the result is a record of nearly 30,000 operations every one of which was successful from the patient's point of view. A short time after the enema is begun, ether is evolved from the patient's breath, but usually before he is aware of the odor of the anæsthetic, a gentle sleep has intervened.

Since an enema is often administered before an operation, there is no occasion to tell him that it is imminent. There is no occasion to tell him even which enema is made with the oil-ether solution, and thus the whole horrible dread of the thing is avoided. When the patient awakes there is no nausea, no retching; he is all bandaged, and the surgical business is finished.

In the army abroad when wounds of soldiers had to be re-dressed at the front and base hospitals, the men suffered tortures. Dr. GWATHMEY harked back to his investigations with Dr. BASKERVILLE on oil-ether colonic anæsthesia. He was reminded also of the rapid-fire action of ether when taken as an intoxicant in Ireland and by "Piccadilly Willies" in London. So he prepared an "oil-ether cocktail" in which the British army surgeons joined him. "The initial auto-human experiment," says Dr. BASKERVILLE, "was a success." Two thousand wounded soldiers after that were given such "cocktails" prior to dressing their serious wounds. The soldiers enjoyed the first exhilaration, dropped asleep, and three hours later awoke refreshed and all unconscious that their wounds had been completely examined and re-dressed. Some of our own surgeons since returning have availed themselves of the method in civilian practice in dressings after operations.

Readers' Views and Comments

Who Is a Chemist?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Any man who has been fortunate enough to receive chemical training and who has even martyred himself in the cause of science will not be so presumptious as to boast that he is trained to meet a multiplicity of problems. That the real chemist differs from the craftsman in that his mind is trained to meet a multiplicity of problems is undoubtedly true if we properly interpret multiplicity. The word as it appears in the subject editorial seems rather broad and perhaps more inclusive than is desired or can be verified in the cold world of facts.

This age of specialization renders constant application to the study of one field imperative to the man who would attain success. The expert metallurgical chemist would find himself entirely incompetent to be consulted on a problem in sugar refining. A chemist proficient in the science of distilled liquors would find himself wandering aimlessly if confronted with a mountain of oil shale. Thus it seems that multiplicity is not the proper word. Perhaps its scope in the explanation should be restricted.

The task of educating the public in a chemical way and to such an extent that the service and necessity of chemistry will be appreciated involves something besides the certification and legalization of the profession. Perhaps the chemical ignorance of the public is due to reluctance on the part of the men who are competent to come forward with an educational program. The fact is that the men who have given their lives to the pursuit of the subject are not prone to proclaim their proficiency from the housetops.

Lawyers and doctors are legalized, and rightly so. Are we to believe that the public has become aware of the necessity and service of the lawyer because of the legalization of the profession? The people caused the legalization of the profession by demanding protection from professional quacks. The people realize the danger underlying the employment of incompetents. The danger incident to the practices of unscrupulous "chemical experts" is not appreciated because the public has not the knowledge necessary to differentiate between their "merits" and demerits.

It has been through legislation arising from the demand of the people for protection that we know "who is a lawyer." The question "Who is a chemist?" will not be satisfactorily answered until the public realizes the need for a new protection.

Worcester, Mass. G. C. McCORMICK.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Some time ago you asked this question in an editorial, and stated that it has not been answered yet. May I submit my suggestion as to this most important matter?

Chemistry today, both as a pure science and in its practical application, has come to the front in everyday life, in national development as well as in the welfare of mankind in general, to such an extent that it forms the broad foundation on which every future progress of civilization will rest. This pre-eminent position of the chemical art is, however, not yet recognized by the general public, and this goal can be reached only by systematically educating and training the youth during school life in the all-important fundamentals of chemistry. This requires introduction of a correspondingly reformed school curriculum in grammar and high schools, as I had already outlined eight years ago in a special treatise on this subject, which found due recognition by high authority.

In the meantime it is of greatest importance, in regard to the high level of the chemical profession having been reached today, to determine who is its true and able representative—i.e., who is a real chemist. The word "chemist" must involve first of all a broad fundamental knowledge and training in the pure science of chemistry, on which rests the higher art of its practical application and its eminent cultural influence. Any man or woman is a chemist who possesses such a professional education along the science of chemistry that he or she is able to understand and to follow up with sufficient knowledge and clear vision every progress and problem within the realm of the chemical profession, be it in pure science or in its practical applications.

From the viewpoint of this definition, a man who practices chemical analysis from a routine standpoint only, without deeper knowledge of the scientific fundamentals of his art of chemistry in general, may be called an analyst, or better still a chemical analyst, but not a chemist, not even an analytical chemist. The latter is a chemist in its broader and higher sense, who makes chemical analysis his specialty. A chemical engineer is not a chemist, but rather an engineer with some chemical knowledge. An engineering chemist is a chemist who has some knowledge of engineering work as applied in industry. An electrochemist is a chemist with sufficient knowledge in electricity. A metallurgist without a broad general scientific knowledge and training in chemistry is not a chemist—if so, he may be called a metallurgical chemist. In this way any chemist may become a specialist in some chemical branch line and express his position accordingly.

The main point is that not everybody is a chemist who practices chemistry in some way or other with more or less skill; he may be a chemical worker of some kind, but not a chemist. The word "chemist" must become an exclusive title of high standard and meaning, according to the growing influence of chemistry and its art in cultural, economic and social life.

As soon as the question "Who is a chemist?" is satisfactorily solved the next important task would be to create an "American Chemists' Institute," whose membership and purpose would differ from the American Chemical Society essentially in the following points:

1. Only recognized chemists are admitted as members.
2. The main purpose of the new institute should consist in recording every achieved progress as well as any prospective new problem in pure and applied chemistry, thereby becoming the guiding authority along research for every individual worker. Publishing annual symposiums on all respective subjects.
3. Through special publications and lectures giving instruction and information to the general public re-

garding the influence of chemistry's progress on home and public life.

4. Establishing a universal library embracing every branch of chemistry, as a center for reference work.

5. Exercising influence to bring chemistry into the forefront of school education as being of fundamental importance for both sexes, especially in regard to health, hygiene and efficiency, constituting a national problem of the first order.

There are, of course, several other tasks which could be included in such a new organization, which, however, may be easily fixed and worked out after the fundamental statutes are determined. J. PERINO.

Sewickley, Pa.

Plantation Rubber and the Testing of Rubber

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I be permitted to comment on the review, in your issue of Jan. 5, of my book on rubber?

(1) Your reviewer's statement that I have "omitted all mention of the valuable papers on rubber which have appeared in CHEMICAL & METALLURGICAL ENGINEERING during the past five years" would seem to indicate that he has not read the book with much attention. In fact, mention is made of all such papers in which are reported original work bearing on the aspects of rubber discussed in the book, the paper by Kratz and Flower (CHEM. & MET. ENG., vol. 20, p. 417) being treated particularly fully. I may add that, so far from having failed to recognize the value of the papers on rubber which have appeared in CHEM. & MET., I have always found A. H. King's articles on various aspects of rubber technology to be of great interest and value.

(2) "The literature references," says Dr. Dannerth, "are for the most part English and Dutch, although one finds casual references to the work of Kratz, Flower, Tuttle and Cranor in the United States." The implication that I have paid a disproportionate amount of attention to the work on rubber, relevant to the aspects discussed, which has been performed in certain countries and have neglected that performed elsewhere, particularly in the United States, is, I venture to assert, not in accord with the facts. Your reviewer refers to the bibliography "in which the author has discovered [*sic*] 350 names of writers on rubber topics." Now an examination of these names shows that actually there are fewer names of English and Dutch than of French and German writers (approximately 130 and 170 respectively in the two groups). Further, nine pages in all are devoted to work published by Kratz; Tuttle's papers have been on matters of chemical analysis with which the book is not extensively concerned; Cranor's paper was published as late as December, 1919, when the book was in the press; and reference is made to an earlier-received private communication from Mr. Cranor. All other published work conducted in the United States which bears on the subjects treated, such as the work of Spence, Wormeley and the Bureau of Standards, is discussed fully.

(3) Dr. Dannerth's complaint that "all reference to synthetic rubber has been carefully deleted [*sic*] from the book" strike me as captious, not to say unreasonable, since the title of the volume, "Plantation Rubber and the Testing of Rubber," would, one imagines, hardly convey the expectation that synthetic rubber was within its scope.

(4) Your reviewer confesses that "a great deal of material on the physics and physical chemistry of rubber has in the volume been published in book form for the first time," and yet he concludes that the book "will probably be of greater value to university men than to rubber manufacturers." Can it be that he fails to appreciate the importance for rubber technology of scientific investigations into the physics and physical chemistry of rubber? I would venture to commend to him an article on "Future Rubber Research" by A. H. King in CHEMICAL & METALLURGICAL ENGINEERING for Sept. 8, 1920, and the following excerpt, quoted in my book, from an editorial in CHEMICAL & METALLURGICAL ENGINEERING for June 15, 1919: "The rubber industry of today can learn a profitable lesson from a comparison of present conditions in the iron and steel industry with those of the 'good old days' before the spread of technical knowledge." G. STAFFORD WHITBY.

Montreal, Canada.

Ownership of Oil-Yielding Shales in New Brunswick

To the Editor of Chemical & Metallurgical Engineering

SIR:—The world-wide importance of an increased supply of hydrocarbon oils makes it very necessary that no person or group of persons shall be allowed, for the furtherance of their own plans and schemes, to make incorrect claims or statements, without the same being contradicted and their falsity made evident.

For some years a conspiracy would seem to have existed in a certain province of Canada, by which certain persons have endeavored to make capitalists believe that they or their friends owned or controlled all the oil-yielding shales of that province. These claims have to my knowledge been made in London, England, and in New York. Because of these claims being persisted in, especially in New York, I wrote as follows to the Hon. James Domville, a Senator of Canada, who resides in the Province of New Brunswick and who has an intimate knowledge of the affairs of that province, particularly as regards oil shales, of which he was one of the first New Brunswickers to recognize the importance. My letter was as follows:

DEAR SENATOR: Lately, when in New York, I was credibly informed that certain parties were claiming that they and their friends owned all the oil-yielding shale deposits in the Province of New Brunswick.

As I have the honor of representing owners of certain New Brunswick shale deposits, and as you are known to be largely interested in other New Brunswick shale deposits, I have considered it my duty to call your attention to this claim, the making of which has done and is doing grave injury to your province.

The Senator replied:

DEAR SIMPSON: I have to thank you for calling my attention to the claims you inform me are being made as to the ownership of the Province of New Brunswick oil-yielding shale deposits.

As you know, I have been interested for over ten years in the Albert mines, a shale property in this province. I have authorized no one to make any claim such as that mentioned by you.

This is not the first time that similar claims have been made by unauthorized or irresponsible parties. The Province of New Brunswick Legislature passed an act on March 26, 1910, entitled "An act to amend 'an act to incorporate the Albertite Oilite & Cannel Coal Co., Ltd.,'" being 1 Edward VII, Chapter 79, page 300. By this act, The New Brunswick Petroleum Co., Ltd, which in 1907 had been granted certain privileges, had those privileges curtailed, *vide* clause 1, which states, "Under the said lease to the New Brunswick Petroleum Co., Ltd., *no interest* in bituminous shales and Albertite was granted to said company."

I am, yours faithfully, JAMES DOMVILLE.

In the interest of the nascent oil shale industry, may I ask you to make public this correspondence.

Ottawa, Canada. LOUIS SIMPSON.

British Chemical Industry

From Our London Correspondent

LONDON, Feb. 15, 1921

AT THE time of writing, the tone of the chemical industry and of chemical markets is one of incipient optimism and cheerfulness and it is generally expected in well-informed circles that there will be a partial revival of trade and industry by June of this year. It is not considered that the removal of the excess profits duty will have any appreciable influence in this connection, the mischief due to its prolonged retention having already been discounted. Most factories are at present working only three or four days per week, the export trade is still very depressed, and in consequence prices are still slightly in favor of buyers. Considerable quantities of caustic potash are now arriving from Germany and, the demand being purely nominal, the market is overstocked.

Considerable friction and dissatisfaction have arisen on account of the peculiar attitude of the large chemical and dyestuffs organizations in regard to export trade. During the war, when supplies were strictly rationed, it was possible to acquiesce in the stipulation that the destination of the goods should be declared, but apparently the manufacturers, having now established their agents and distributing systems in foreign countries, are anxious to continue this inquisition for their own ends, and the result is a state of semi-revolt on the part of the merchants. In several cases recently the merchant has actually obtained the order for the goods from his foreign customer and was refused supplies by the manufacturer solely in order to protect the latter's agents. As a result, several important orders have been placed in Germany and elsewhere and were therefore lost to the home manufacturer on account of what is generally considered as a short-sighted policy. The attention of the government has been called to the situation.

PROGRESS IN DIRECT FUEL SAVING

The campaign for increased efficiency in the use of fuels has gradually spent itself and there is less activity in the installation of coal- and labor-saving devices for the boiler plants of the country. On the other hand, considerable attention has been given to the recovery of washed coke and breeze from industrial ashes and to the froth flotation of coal. A flotation plant to deal with about 1,000 tons per day of coking coal is to be erected at the Skinningrove Iron Works, on the northeast coast, the process used for metallurgical work being suitably modified under the auspices of Minerals Separation, Ltd. It is stated that about 1 lb. of reagent is required per ton of coal treated and that apart from the removal of dirt and ashes, considerable economies are to be expected on account of increased output of the coke-oven plant and improved quality of coke. The gas companies are vitally concerned in the success of the process, particularly on account of the very high percentage of dirt and stone sold to them by the mines along with the coal during the last few years. In view of the high freight rates which are still prevalent, it is expected that considerable net economies will result from the extended use of this process. On the other hand, the large quantity of inert products supplied with present-day industrial coal has greatly increased the carbon content of the ashes from boiler plant, which may be 10 to 20 per cent or more by weight. The Fuel Recovery Syndicate is now developing the Lioud process for treating ashes, the usual size of plant dealing with about ten tons per hour and the cost being about 10s. per ton of recovered washed coke or breeze. Two plants are already at work in this country and a large number in France.

PROPOSED FORMATION OF BRITISH ENGINEERS' CLUB

The example set by the Chemical Industry Club is apparently to be followed by the formation of a similar organization for engineers, and curiously enough the provisional committee also includes representatives of the chemical industry like Max Muspratt, Mr. Woolcock, M. P., and Sir Robert Hadfield. The general feeling is that a club of this kind will not prove a success at the present time unless the subscription is sufficiently low to bring it also within the reach of the younger members of the profession. The idea of a central home and club for all engineering societies has often been mooted, but could not come to fruition on account of the existing and very adequate buildings of the leading societies.

FINE CHEMICALS AND DYESTUFFS

The views outlined in my last article have been confirmed by an official statement just issued by the Association of British Chemical Manufacturers, which predicts the collapse of the industry unless a bill complementary to the dyestuffs act is passed. No final decision has as yet been reached in regard to the proposed key industries bill, but it is quite certain that heavy chemicals will not be included and fine chemicals will probably be restricted mainly to pharmaceutical products. On the other hand, there seems to be so much opposition and uncertainty that it is by no means impossible that the fine chemical industry will be left to work out its own salvation.

CHEMICAL PUBLICATIONS AND GENERAL NOTES

Considerable discussion and some amusement has resulted from the proposals submitted by the Federal Council for Pure and Applied Chemistry for the publication of chemical literature. To some extent the suggestions made follow the lines of the corresponding American journals, but it is suggested that the various societies should establish a joint weekly journal practically on the same lines as CHEMICAL & METALLURGICAL ENGINEERING. It is refreshing to notice the intense keenness which is being displayed in regard to the value of such a journal as regards advertising revenue, but it is felt that until the societies concerned can make up their minds to abandon control by committees in favor of sound and commercial journalism, a weekly journal of this kind will meet with little support, particularly as the public is already well served by several trade papers. There is also the fear that advertising revenue will seriously diminish in the near future, partly on account of the removal of the excess profits duty and partly on account of industrial depression.

The first volume of the new edition of Thorpe's Dictionary of Applied Chemistry has just appeared and is to be followed by six or seven additional volumes to complete the series.

The Kelvin gold medal has been awarded to Dr. W. C. Unwin, F.R.S.

American Ceramic Society, Annual Meeting

Assembled at the Birthplace of the Society, the Members Hold Scientific Fest — Papers Show Need for Enlarged Technical Control of Processes and Widened Scope of Industrial Activity—Results of Original Research Made Public—Abstracts of Papers

THE twenty-third annual meeting of the American Ceramic Society was held at the Deshler Hotel, Columbus, Ohio, Feb. 21 to 24. Significant in its location, near the largest ceramic industries of America, inspired by the presence of Edward Orton, Jr., dean of American ceramists and virtually the father of the society, who was surrounded by many distinguished senior ceramists, the meeting held far more than the usual amount of spirit and morale manifest on like occasions.

The society is one where every member is the other fellow's friend. The smoker on Monday night and the informal dance and banquet on Tuesday evening were more like functions of an intimate social organization than perfunctory affairs of the national technical society. The emotions of the banquet assembly were varied from laughter at W. D. Gates' description of sweaters for keeping interurban engines warm to tears at the touching tribute paid to Ernest Mayer by Toastmaster Orton. The special entertainment for the ladies and the visits to industrial plants in the vicinity displayed hard work and good judgment on the part of the local committee. The visit to Edward Orton's cone factory, the Bureau of Mines ceramic station and the university was like a pilgrimage to an old shrine.

With old traditions of art commingled with ideals for the science and industry of the future, it is little wonder that the meeting was a success for every member and division.

Business Meetings

Officers elected for 1921 were as follows: F. K. Pence, president; F. B. Ortman, vice-president; R. K. Hirsh, treasurer; R. M. Howe, trustee; E. W. Washburn, editor of the *Journal*.

The glass division has been invited to tour industries in England by the English society. The executive committee is considering the appointment of a full-time secretary. Arrangements are made for preparing abstracts of ceramic literature in co-operation with the American Chemical Society.

The American Ceramic Society has voted to join the Federated American Engineering Societies, if financial arrangements can be made.

Edward Orton made an eloquent plea that proper steps be taken to perpetuate the name of Ernest Mayer by suitable memorial, and a committee of five was appointed to work out details.

Presidential Address

R. H. Minton's presidential address on "Some Problems to Be Solved" revealed a masterful grasp of the situation existing in the ceramic industries today and was referred to a special committee for careful analysis and disposition in the form of instructions to the divisions of the society. It is abstracted in part in the following paragraphs:

With oxygen, silica and alumina forming 85 per cent by weight of the elements of the earth, we can conceive the magnitude of the foundations of our work. Secret methods are no barrier to technical competition. The future problems are chemical and physical on one hand and mechanical and human on the other. Scientists must solve our general problems, involving fundamental laws affecting drying and firing, heat transmission and heat losses, problems of combustion and kiln construction, kinds of fuel and control of processes.

The glass manufacturer needs knowledge of chemical reactions and physics of heat-treatment. Silica brick, quartz glass and porcelain industries need technical advice. Research into the chemical composition and properties of glazes is needed. More must be learned of the relation between glazes and frits and the solubilities of lead glazes. Specifications are needed for refractories.

Other problems are the disintegration of clay products by weathering, the dunting of sanitary and terra cotta bodies, the failure of refractories under load and the improvement of electrical porcelains. Plasticity of clays is also a most important subject. The mechanical and organization problems are vital engineering subjects. Standardization of methods and products is badly needed.

Research and development in many lines must come. For our purposes chemistry and physics are the most important. We must co-operate with and support government bureaus. Economic co-operation in market development, both foreign and domestic, must come. We should solve the employment situation. It is the function of the American Ceramic Society to promote all these interests in the clay industries.

Enamels Division

Fish Scaling

The Causes and Control of Fish Scaling of Sheet Steel Enamels, by R. R. Danielson and W. H. Souder. The U. S. Bureau of Standards conducted an extended investigation with simple gray ware enamels and commercial formulas. These were applied to 20-gage steel and the effects noted on variations in firing, thermal expansion of enamels, annealing composition of steel and mechanical treatment of steel.

The fundamental cause of fish scaling lies in the difference of coefficients of expansion of enamels and steel, that for steel being higher than for enamels, so that the latter is under compressive strain. The factors influencing this phenomenon are composition of enamel, overfiring, with consequent volatilization of part of contents, and lack of annealing the enameled ware, which is glass and must be so treated. Secondarily, fish scaling is influenced by the physical condition of the metal, elastic strength of the glass, underfiring and cleanliness of metal surface.

It may be remedied by adjusting the enamel coefficient

of expansion to fit that of steel—i.e., by decreasing its boric acid content; by changing composition to increase strength, and by treatment of metal to give best adhesion, as by cold-rolling, etc., and correct preparation of ware in cleaning process. This paper was accompanied by numerous charts and curves to substantiate the findings.

John S. Grainer followed with a plea for further scientific investigation and increased technical control of the industry, reviewing conditions where secrecy and unwillingness to co-operate on the part of the practical enameler have stifled progress. He attributed fish scaling to overfiring, poor composition and poor furnace construction and spoke highly of the excellent work done by the Bureau of Standards. An explanation of fish scaling was also undertaken by J. F. Bardbush, and the three papers are a distinct addition to the literature.

Copper Enamels

Copper enamels were covered in two papers. A preliminary report of work being carried on by B. T. Sweely stated that with an arsenic content of 0.1 equivalent As_2O_3 in an enamel of one type applied by the dry method the following relations held true: (1) Increase of silica with RO, arsenic and boric constant. increases tendency to fracture, increases refractoriness and does not affect opacity and luster. (2) Increase of boric acid above 0.2 equivalent causes enamels to matt. (3) Increase of K_2O at expense of PbO causes enamels to flow better and to mature at lower temperature, increases solubility and decreases tendency to fracture. (4) High-lead enamels are opaque, but do not flow well and attack the copper.

The following limits were recommended:

$$\left.\begin{array}{l}0.3\text{-}0.6\ KNaO\\ 0.7\text{-}0.4\ PbO\end{array}\right\}\left\{\begin{array}{l}0.05\text{-}0.15\ As_2O_3\\ 0\text{-}0.2\ B_2O_3\\ 1.3\text{-}1.8\ SiO_2\end{array}\right.$$

R. R. Danielson followed with an outline of his investigations on twenty white enamels for copper. While the number of investigations was small, he offered the following results: (1) Correct smelting is extremely important, slow air cooling of frit is preferable to water quenching and repeated smelts promote opacity and eliminate gas. (2) Certain reducing atmosphere in the furnace eliminates copper oxidation. (3) Slight changes in composition have a decided effect on resultant properties. (4) Sodium oxide promotes glass but reduces opacity. (5) Lead oxide promotes fusibility without materially reducing opacity. (6) Cryolite is not desirable, as it tends to promote matt finish. (7) Keep B_2O_3 content low. (8) Arsenic is an excellent substitute for tin oxide.

Two of the formulas showed best for watch dials and three others for thermometer scales, sign letters, etc.

Solubility of Enamels in Acids

Solubility of enamels in acids as related to the composition was discussed in an exhaustive paper by Homer F. Staley. The question is important in the manufacture of chemical ware used in the many industries. The various materials affect the acid resistance in the following order, the most advantageous being named first: Al_2O_3, cryolite, Na_2O, PbO, BaO, Li_2O, MgO, CaF_2, ZnO, SrO, CaO and B_2O_3.

When substituted one for another in equal percentage amounts, various oxides and minerals affected the resistance of enamels to the action of boiling 20 per cent hydrochloric acid in the following order, the most favorable being named first: Al_2O_3, MgO, CaF_2, ZnO, SrO, CaO and B_2O_3. The first five are especially desirable, while the remainder are undesirable. The relative effect of the materials used in the experiments was the same with various base enamel compositions. When substituted one for another ZrO_2, TiO_2 and SiO_2 affected the resistance in the order named. The favorable action on acid resistance conferred by ZrO_2 is offset by a tendency to produce excessive chipping. Rutile gives less chipping than either zirconia or silica and greater acid resistance than silica.

Wet Process Enamels for Cast Iron

R. R. Danielson gave the results of preliminary work at the Bureau of Standards in developing wet process enamels for cast iron. This information was of particular value to many manufacturers, especially producers of stove parts. The subject hinges on the development of a suitable ground coat. Refractory ground coat showed greater freedom from pinholing. A medium amount of raw material in mill additions is desirable, since high contents give rise to flaking and small amounts give rise to pinholing in the cover enamel. Clay is a better mill addition than flint or feldspar. The composition of the frit portion is more important than mill additions. Dry process ground coats are not necessarily suitable for the wet process. It is desirable to continue the study of this subject.

Firing Enamels

A. Malinovsky's paper dealt with the melting of enamels in rotary furnaces as compared with the ordinary reverberatory type, the former showing more uniform product, freedom from contamination by rabble irons and furnace linings, lower losses through adhesion to walls and lower fuel consumption. He described the construction and operation of a U. S. Smelting Furnace Co. furnace with lantern slides.

L. E. Barringer gave a treatise on the application of electric heat to vitreous enameling, with particular reference to the furnace developed by the General Electric Co. This most recent addition to the art is attracting considerable attention in the enameling industries.

B. T. Sweely gave notes on the acid resistance of enameled cooking utensils as affected by the position of firing. The under surfaces of pieces as placed in the ovens are more resistant to citric and acetic acids than the upper sides. The inner surfaces of enameled vessels may be made more resistant to acids of the kitchen by firing in an inverted position.

Refractories Division

Molds for Magnesite, Chrome and Silica Brick

Erling E. Ayars described at length the best types of molds for making magnesite, chome and silica brick. Slip molds are used for silica brick. Chrome and magnesite brick are made largely by machinery and a machine is now being developed for pressing out silica straights. Special shapes will eventually be eliminated from coke-oven construction and only 9 in. straights employed.

Testing Coke-Oven Refractories

F. A. Harvey offered a complete report on the methods of testing coke-oven refractories together with specifications for them. The paper was the result of several years' intensive work on the subject in con-

nection with the ovens of the Semet-Solvay Co. The proper testing of refractory materials requires a clear understanding of conditions both ordinary and extraordinary which the materials must meet in service. The tests must then be made for size, warpage, ring, load and vitrification; reheating to 1,450, 1,350 or 1,200 deg. C. as required; fusion point; bulk density, apparent density, true density and porosity; bending and load; crushing and modulus of rupture, spalling, fineness, plasticity and heat conductivity.

All silica brick and shapes must pass the 1,200 deg. C. reheating test and show not more than 1.6 per cent average permanent linear expansion. For regenerator checks up to 2 per cent can be allowed. Lime content should not be specified until more complete data on the effect of lime are available. Alumina should not exceed 1.65 per cent. For fineness of grind 97 per cent of material should pass a 1/4-in. mesh screen. All class 1 silica brick should have a modulus of rupture of not less than 500 lb. and a cold crushing strength of not less than 1,600 lb. per sq.in. Class 2 silica brick should have a modulus of rupture of not less than 350 lb. and cold crushing strength of not less than 800 lb. per sq.in. Class 1 brick should be used in bench walls, corbels and oven linings. Shapes should not have a variation in dimensions greater than 1/16 in. per ft. for brick under 12 in. and 1/8 in. per ft. for larger pieces. Visual inspection and hammer tests should eliminate cracked and badly warped pieces.

Clay brick in the reheating tests should not show a swelling greater than 1 per cent nor a shrinkage greater than 1.6 per cent. Bending tests should not show greater than 3/8 in. for 1,450 deg. C. heat and 1/4 in. for 1,350 and 1,200 deg. C. heats. Dimensions should not vary more than 1/8 in. for standard sizes under 12 in. nor more than 3/16 in. per ft. for sizes over 12 in. Statement must be made as to whether brick is hand or machine made.

Silica cement must have fusion point as high as cone 27, must all pass 30-mesh screen and must survive the pail test. It must contain not over 25 per cent plastic clay.

Fireclay ("A" quality) should spread easily and smoothly with trowel, pass 14-mesh and 95 per cent pass a 20-mesh screen, and fuse not lower than cone 28. "B" quality may fuse as low as cone 20.

Zirconia Cements

Mark Sheppard's paper on zirconia cements brought out the fact that crude zirconia with high shrinkage and impurities could not be bonded with clay to make a satisfactory cement. When a part of the crude zirconia, however, was partly replaced by pure zirconia, the purified material having lower shrinkage, a cement could be formed. When this was applied as a wet wash to a bung on malleable furnaces, an increase of 25 per cent was secured in the number of heats run before replacement.

Heat-Treatment of Silica Brick in the Crown of a Tunnel Kiln

A. A. Klein in discussing the heat-treatment of a silica brick in the crown of a tunnel kiln stated that after the heating it contained no quartzite, low amount of tridymite and nearly 100 per cent crystoballite where the previous composition had been equal parts of each. This is evidence that all quartzite tends to change over to crystoballite on heating.

J. W. Hepplewhite proposed a departure in the method of measuring actual thermal conductivity of refractories by bringing both sides of brick to a high temperature and measuring the heated air delivered from a chamber on the cooler side. Some discussion followed his description of the apparatus and suggestions were made as to methods of overcoming difficulties encountered in performance.

W. Henry Grant has found little information available as to the major cause of failure of firebrick in oil-burning furnaces. The brick do not burn but disintegrate. A dense fine grind made into hard-burned firebrick has been found to give best service.

R. M. Howe in tests conducted at the Mellon Institute with a flint clay firebrick in which the plastic clay bond was kept constant and various amounts of gannister were added, displacing the flint clay, found that the addition of gannister increased the resistance to spalling at intermediate temperatures. At higher temperatures no advantage was discovered and at the lower limiting temperature for firebrick a disadvantage was encountered in the tendency to lower the melting point as the mix approached the eutectic for alumina and silica.

Glass Division

Training of the Glassworks Chemist

Alexander Silverman outlined a suggested college course for the training of the glassworks chemist, with a first year course to include general inorganic chemistry, mathematics, English, German and some general work in the factory. Second year should include advanced inorganic chemistry, advanced physics, mathematics, German or French, quantitative and qualitative analysis and factory work. The third year should embrace physical chemistry, quantitative analysis, mineralogy, pyrometry, microscopy, organic chemistry and laboratory work in the factory. The final year's work should include clays and refractories, glass technology, ceramic calculations, engineering laboratory, electrical engineering and factory management.

Some think the glass chemist is so specialized there is no need for him in the industry, but the training suggested coupled with practical experience will develop a man to become an important factor in industrial development.

Composition of Barium Glass

R. J. Montgomery gave the result of research in the composition of optical glasses whose properties are dominated by the barium oxide content. The batch is more complex than that of lead glasses, which have a three-component system of alkali, lead and silica, while barium glasses have a second acid (B_2O_3) introduced together with Al_2O_3 as well as more complicated RO, containing zinc and calcium in addition to alkali and barium.

There are no simple relations between composition and optical properties, and the relations as observed in the charts must be expressed in the most general terms. Deductions were made on BaO versus optical properties, B_2O_3 and SiO_2 versus optical properties, SiO_2 versus BaO and SiO_2 versus alkali. The proportioning of the RO bases, the Al_2O_3, ZnO and alkali contents was discussed. Each particular glass is a problem in itself and the details cannot be covered in a general paper.

Dissolved Gases in Glass

E. W. Washburn gave an exhaustive report of investigation of dissolved gases in glass, which in addition to appearing in the *Journal* of the American Ceramic Society will shortly be issued as Bulletin 118 (1921) by the University of Illinois Engineering Experiment Station. The work was begun in 1917 and is just completed. The results to date lead to the conclusion that all varieties of glass in the finished state contain dissolved gases. The amount of this dissolved gas is sufficient to cause the glass to effervesce violently if the pressure upon it be suddenly reduced while in a fluid condition. The amount and composition of the dissolved gas varies greatly with the type of glass and the detail of the melting and fining procedures. In three types of industrial glass examined, the volume of the dissolved gases, measured under standard conditions, varied from 0.2 to two times the volume of the glass itself. Carbon dioxide, oxygen and nitrogen were found in various amounts in the gas.

The Operation of Leers

C. E. Frazier spoke on the essentials of proper annealing of glass articles from a practical standpoint. The factors involved are the shape, weight, temperature at which the glass is worked and whether the article is blown or machine made. The strains created in the latter will be proportional to the difference in temperature between the plunger mold and the glass. The annealing temperature varies from 800 to 1,100 deg. F. and the time from 45 min. to 1 hr. 20 min. Proper annealing involves correct mold design, working temperature, temperature annealing chamber, soaking time and a gradual cooling on removal from annealing chamber. Comparisons were made of the open, muffled and continuous leer.

Heavy Clay Products

This division was organized with Ross C. Purdy chairman. The scope of activity will include common brick, drain tile, facebrick, sewer tile and other fields involving the heavier ceramic industries. The discussion centered on the co-operative movement with the various national associations of these products. A. V. Bleininger reported the work as carried out by the ceramic committee of the National Research Council. The hollow tile producers are also inclined to join. Joint conferences have been held by the executive committees of all these associations and all approved the plan for each association to appropriate $10,000 a year for two years to establish a fund for research and have recommended it back for approval by each association. The formation of this division for the work will greatly increase the American Ceramic Society's membership.

The Art Division

Under the chairmanship of Frederick H. Rhead of Zanesville, Ohio, the new division giving art a definite place in the society was formed. The following papers were presented at the close of the business session:

"The Mutual Relations of Art and Technology in the Ceramic Industry," Leon V. Solon, New York City; "Relationship of the Artist to the Manufacturer," Conrad Dressler, Cleveland, Ohio; "Some Suggestions for Research in Commercial Decorative Processes," Frederick H. Rhead, Zanesville, Ohio; "Ability of Variable Glaze Compositions to Take Vapor Lusters," Ray T. Watkins, Columbus, Ohio; "Nickel Oxide in Glazes," J. D. Whitmer, Zanesville, Ohio; "A Study of Crystalline Glazes," Hobart N. Kraner, Columbus, Ohio.

Kilns

As in previous years, the general session included a symposium on kilns directed by R. H. Minton, which was attended by members from all branches of the society.

Data on a Dressler Kiln

F. H. Riddle gave some real data on a Dressler kiln which had been in operation seven months at cone 18. The condition of the structure at the end of the period was classed as a temporary delay and not a failure. Many have been skeptical about the success of tunnel kilns above cone 11. Cone 20 has been reached in the case at hand. The structure is 300 ft. long with silica brick arch in the hot zone (40 ft. long) and the remainder firebrick. Photographs showed the rise in this arch due to greatest heat, 2,678 deg. F., was 1⅜ in. The flue boxes were replaced with carborundum brick. The mortar stood up well, but reacted with the carborundum to break the latter down. Where no binders were used the carborundum stood up well.

Examination of the silica brick in the hot zone (2,400 deg. F.) showed that the edges next to the heat were completely converted to tridymite and the outside edges crystoballite. There was no difference in expansion between the two parts of the brick. Electric porcelain can be burned in the tunnel kiln.

Description of a Unique Kiln

C. B. Harrop spoke on the construction of two of his kilns installed at the Mt. Clemens Pottery Co., Mt. Clemens, Mich. The installation was unique in that two kilns were placed end to end for bisque and glaze burning. The former is 325 ft. long operating at cone 10 and the latter 273 ft. long at cone 5. They are burning white ware in this open-fired, hand-stoked type. The ashes are automatically removed. The firebox has an enlarged throat and the walls of the main chamber are sloped in at the top to produce even distribution of heat.

The coal burned is Elkhorn Kentucky grade and burns one dozen bisque for every 1.22 lb., against 7.8 lb. consumed in periodic kilns.

Compartment Kiln for Clay Products

W. D. Richardson gave a paper on the adaptability of the compartment kiln for clay products. Attention to fuel saving is becoming important. The tunnel kiln has been the dream of potters for a long time. In the old experiments with this type it was found that the only installations that could not be inspected were those that failed. The latest compartment kiln development can be adapted to any type of ware where gas is employed for heating. No saggers are required to protect ware. It saves from 50 to 60 per cent of fuel over the periodic kiln, is compact and adaptable to plant conditions, requires no ash handling, has better burn control, uniform product, low repair costs, and a wider range of practical utility than any other type.

The Shaw Compartment Kiln

R. H. Minton spoke on the Shaw compartment kiln, stating that these are used widely in England, while the tunnel kiln is popular in Germany. The former compares favorably with the tunnel kilns for fuel economy and is more adaptable to existing plants.

Investigations of the Chemical Literature—I

A Survey of the Field of Chemical Literature and of the Various Kinds of Searches or Investigations—Library Research—Use of Card Index Catalogs, Shelf Lists and General Reference Works*

BY FRANK E. BARROWS†

THE chemical literature is the storehouse of the available published information of chemical science and chemical industry. It is most extensive, both in the wide range of subjects which it includes and in the long period of time over which it extends. Investigations of this literature are often required. Proper investigation requires a familiarity on the part of the investigator with the various sources of information and with the facilities available for using them. The importance of proper training and guidance in making investigations of the chemical literature is not as generally recognized as it should be.

The present paper is a contribution to the general subject of the chemical literature and its investigation, and includes a discussion of the use of library facilities and general reference works, and of the searching of the periodical and other literature.

The Field of Chemical Literature

Periodicals

The number of current periodicals systematically examined for *Chemical Abstracts*, according to the list published in 1918, was 789. Bolton, in his "Select Bibliography of Chemistry," published in 1893, lists 436 periodicals, while in his "Catalogue of Scientific and Technical Periodicals, 1665-1895," published in 1897, he gives the following numbers of periodicals as relating to certain branches of chemistry: General chemistry, 154; pharmaceutical chemistry, 30; physiological chemistry, 6; technical chemistry, 94; dyeing and printing, 21; illuminating gas, 30; iron industry, 33; ceramics and glass, 32; metallurgy, 44; mining, 165; oils, fats, soap, etc., 22; sugar, 43; tanning and leather, 11; wines and spirits, 48. Even as early as 1848 Gmelin, in vol. 1 of his "Hand-Book of Chemistry," gives a list of 77 chemical periodicals of earlier date.

Other Literature

In addition to the periodical literature the field of chemical literature also includes the patent literature, the text book literature, and the numerous histories, hand-books, dictionaries, encyclopædias, technologies, pamphlets, bulletins, monographs, dissertations, public documents, trade catalogs, reviews, indexes, bibliographies and other books and publications which relate, in whole or in part, to chemical science or to chemical industry.

Various Fields of Chemistry

In the general field of the chemical literature are numerous branches or subdivisions, including:

Agricultural chemistry, analytical chemistry, apparatus, biochemistry, ceramics, cement, colloidal chemistry, dyestuffs and dyeing, electrochemistry, explosives, fermentation, fertilizers, foods, fuels, gas manufacture, glass manufacture, general inorganic chemistry, leather, metallurgy, mineralogical chemistry, oils and fats, general organic chemistry, paints and varnishes, paper making, perfumes, petroleum oils, pharmaceutical and medical chemistry, photography, physical chemistry, plastics, resins, rubber, sanitation, soap, sugar, textiles, theoretical chemistry, water, and wood distillation.

This list might be elaborated or abbreviated, depending upon the particular standpoint from which the field is considered.

Some of the chemical periodicals are of a general character and embrace many of these branches; others relate to certain branches only. The chemical literature, other than the periodical literature, is likewise in part of a general character and in part specialized and limited to certain subjects or branches.

It is apparent that the chemical literature is of a most extensive character, both in the wide range of subjects which it includes and the long period of time over which it extends.

Various Kinds of Searches or Investigations

Searches or investigations of the chemical literature, of a more or less comprehensive character, may be made from various standpoints—e.g., by the research chemist, to familiarize himself with the available published information along the lines of his research; by the student, as a part of his studies or research; by the writer or author who, in his articles or publications, desires to give credit to the work of others, or to review the prior literature along the lines of his own publication; by the bibliographer, as the basis of his bibliography; by the manufacturer, to obtain information of interest along the lines of his manufacture or along new lines of development; by the patent investigator, in connection with questions relating to the novelty and patentability of inventions, and the validity and infringement of patents, etc.

It will be evident that the character and scope of the search or investigation will vary, depending upon the particular object the searcher has in view.

The value of any search or investigation of a comprehensive character will depend on its thoroughness and completeness, and this will in turn depend upon the facilities available for making the search and upon the ability and training of the searcher in making use of these facilities.

Libraries

The making of any comprehensive investigation necessarily requires that there shall be available a library containing the chemical literature properly classified and accessible for examination.

*Thesis, Armour Institute of Technology.

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Libraries of this character will be found in the larger cities and in many of the colleges, technical schools and universities, although the extent of the chemical literature, both book and periodical, will vary greatly in different libraries.

For many purposes the libraries of Washington offer facilities not elsewhere available. The Library of Congress is an excellent field of search because of its extensive number of publications and its card index catalog, and particularly if permission be obtained to examine the classified works in the stacks of the library. For making searches through the patent literature, both United States and foreign, the library of the Patent Office offers facilities nowhere else available in this country. The Smithsonian and Surgeon-General's libraries as well as those of the Geological Survey, Bureau of Mines and Department of Agriculture are likewise of special value in their respective fields.

Many of the public libraries of the larger cities, as well as libraries such as the John Crerar Library of Chicago, the Franklin Institute Library of Philadelphia and the Chemists' Club and Engineering Societies libraries of New York, also afford excellent fields of search.

In addition to these public libraries and libraries which are generally open to the public there are many private and special libraries, of associations, societies, corporations or individuals, which may contain valuable special collections along certain lines.

The importance and value of proper library service is well illustrated by the fact that at the annual meeting of the American Chemical Society at Buffalo (May 7 to 11, 1919), the program included a "Symposium on Library Service in Industrial Plants," with twelve different papers.[1]

The publication, *Special Libraries*, of the Special Libraries Association contains much that is of interest from the general standpoint of library investigations, bibliographies, etc., and is to be recommended to those interested in such subjects.

In making use of a library's facilities the searcher may proceed in various ways—i.e., with the card index catalog, with the classified books on the shelves of the library, with the general reference works or with the periodical literature.

Card Index Catalogs

Every library of consequence has its card index catalog of the books and publications on the shelves of the library. The librarian is taught that "in any library the card catalog is the main bibliographical tool for that particular library" and that "good cataloging is the basis of all satisfactory service to the public."

In using the card index catalog the searcher will naturally look under the same general or special subjects or headings as in using the various indexes of chemical publications, although it may be necessary to look under more general, rather than or in addition to specific, subjects. After obtaining lists of the publications of the library along the lines in which he is interested he may have the publications brought to him, or he may in many libraries go to the shelves where the books themselves are classified.

Some libraries have special rooms where the more important scientific and technical periodicals and books are separately arranged for convenience of use. Thus in the New York Public Library publications relating to science and technology will be found in four adjacent rooms. Chemistry periodicals and books are in Room 118, physics, mathematics, geology, mining and metallurgy in Room 115, engineering periodicals in Room 117, engineering, patents, electricity, textiles and related subjects in Room 121. A single card index catalog serves as a guide to all the material in this division.

Again, certain libraries have special card index catalogs. The Patent Office at Washington has an extensive card index of the chemical literature, with a formula classification of organic chemical compounds similar to that of Richter's "Lexikon."

Some libraries also include in their card index catalogs reference to leading papers appearing in the current technical and scientific periodicals. The Engineering Library and Public Library of New York include references of this character.

In many fields of chemistry there are special books or monographs devoted to particular subjects and sometimes containing copious references to the patent and periodical literature. A search or investigation may be very materially shortened if such a work is found devoted to the particular subject of the investigation. These works will usually be referred to in the card index catalogs.

Shelf Lists

From the card index catalog of the library the searcher can ascertain the classes where the particular books in which he is interested are classified. He may find that some of the books are in one class, some in another, still others in a third, and so on. If it is permissible to go to the shelves or stacks of the library he may find in these same classes still other books of interest which he did not find from the card index.

Information about the classification and arrangement of the books on the shelves, and even about books and publications relating to the particular field of the investigation, may frequently be obtained from the librarian or assistant in charge.

It is useful to keep in mind that both the Dewey decimal system of classification and that of the Library of Congress provide for the separate classification of science and technology. Thus in the Library of Congress classification Class Q relates to science and Class T to technology. Chemistry is classified in Class QD; chemical technology in Class TP. Agricultural chemistry is separately classified in Class S (agriculture); medical and pharmaceutical chemistry in Class R (medicine); physiological chemistry in Class QP (science); mineral industries, including metallurgy, fuels, etc., in Class TN (technology), etc. Some publications relating to chemical subjects are also classified in the class of economics (Class H), while others may be found in sets of Government publications or among series of bulletins or publications of universities, etc., and separately classified for that reason. For a complete search of the library's facilities, accordingly, it is important to use both the card index catalog and the shelf lists relating to the particular subjects of the investigation.

General Reference Works

For some purposes it is more profitable to begin with the general reference works, which will be found in considerable number in all of the larger and more important libraries, than with the card index catalog or the classified shelf lists. These general works include dictionaries, hand-books, encyclopædias, technologies,

[1] See *J. Ind. Eng. Chem.*, vol. 11, pp. 578-589, June, 1919.

bibliographies, indexes of various kinds, etc., and are often separately classified from the rest of the chemical literature.

Some of these reference works will themselves be found to contain a great deal of information on many different subjects, particularly in the case of dictionaries and technologies, and some of the hand-books and encyclopædias; others will be found to consist mainly of indexes or bibliographies which direct the investigator to the periodical literature for further information. Sometimes reference works such as Beilstein or Richter, in organic chemistry, or Gmelin-Kraut or Abegg, in inorganic chemistry, will be the best place to start in making the investigation.

Some of the general reference works that may be used to advantage in making investigations are briefly referred to below. This list does not purport to be at all complete, but is intended rather as illustrative.

Dictionaries

Thorpe's "Dictionary of Applied Chemistry," published 1912-1913, in five volumes, is one of the best known and most valuable of the chemical dictionaries. It contains many valuable monographs and numerous references to the original literature.

Watt's "Dictionary of Chemistry," published 1892-1894, in four volumes, is an older but in some respects an even more valuable work.

Wurtz's "Dictionnaire de Chimie Pure et Appliquée," in three volumes, published in 1874, with its First Supplement, in two volumes, and its Second Supplement, in seven volumes (published 1892-1908), is another valuable reference work, and contains numerous references to the original literature.

Encyclopædias

Fremy's "Encyclopedic Chimique," in ninety-three volumes, published 1882-1890, with an index volume (Table Alphabétique des Matières) published in 1899, is an elaborate work, but not as valuable as its size would indicate.

Ullmann's "Enzyklopædie der technischen Chemie," still incomplete, is a valuable work. Eight volumes are now available.

Hand-Books

Gmelin's "Hand-Book of Chemistry" was translated by Watts, and published by the Cavendish Society, in eighteen volumes, the first six of which relate to inorganic chemistry and the last twelve to organic chemistry. The first volume was published in 1848, the eighteenth volume in 1871. A separate index volume was published in 1872. Seventy-seven periodicals are listed in the beginning of the first volume. The original German work of Gmelin was published in seven volumes, three relating to inorganic chemistry and four to organic chemistry.

This publication is one of the best and most valuable of the early reference works, and it contains, in digest or abstract form, reference to most of the important chemical literature prior to the middle of the Nineteenth Century.

There is a tendency among students and among some chemists to consider that the main strides in the advance of chemical knowledge have been within the last few years, but reference to Gmelin's Hand-Book shows that far more information was available half a century ago, both in inorganic and organic chemistry, than is commonly appreciated.

Perhaps the most elaborate and exhaustive digest of inorganic chemistry is Gmelin-Kraut's "Handbuch der anorganischen Chemie." This hand-book follows the same general plan as the earlier hand-books by Gmelin, giving a bibliography at the beginning of each subject and a discussion of the properties, methods of preparation and commercial methods of manufacture of the various metals and of their various compounds. About 170 periodicals are listed in the introductory portion of the first volume. The work is still incomplete, but the volumes which have been published and the fields which they cover, are indicated by the following table:

Vol. 1, Pt. 1, published 1907, 888 pages. Oxygen, Hydrogen, Helium, Argon, Neon, Krypton, Xenon, Nitrogen, Sulphur, Selenium.

Vol. 1, Pt. 2, published 1909, 441 pages. Fluorine, Chlorine, Bromine, Iodine.

Vol. 1, Pt. 3, published 1911, 907 pages. Phosphorus, Boron, Carbon.

Vol. 2, Pt. 1, published 1906, 512 pages. Potassium, Rubidium, Calcium, Lithium, Sodium.

Vol. 2, Pt. 2, published 1909, 726 pages. Barium, Strontium, Calcium, Magnesium, Glucinum, Aluminum.

Vol. 3, Pt. 1, published 1912, 1568 pages. Titanium, Silicon, Chromium, Tungsten, Molybdenum, Uranium.

Vol. 3, Pt. 2, published 1908, 1135 pages. Radio-active material (Uranium, Thorium, Radium, Polonium, Radio-Tellurium, Radio-active Lead, Actinium and Emanium, etc.), Vanadium, Manganese, Arsenic, Antimony, Tellurium, Bismuth.

Vol. 4, Pt. 1, published 1911, 1056 pages. Zinc, Cadmium, Indium, Gallium, Germanium, Tin, Thallium.

Vol. 5, Pt. 1, published 1909, 1595 pages. Nickel, Cobalt, Copper.

Vol. 5, Pt. 2, published 1914, 1752 pages. Silver, Gold, Mercury.

Vol. 5, Pt. 3, published 1915, 992 pages. Platinum.

The unpublished volumes of this Hand-book are as follows:

Vol. 4, Pt. 2, Lead, Iron.

Vol. 5, Pt. 4, Palladium, Rhodium, Iridium, Ruthenium, Osmium.

Vol. 6, Zirconium, Thorium, Tantalum, Niobium, Cerium, Lanthanum, Didymium, Neodymium, Praseodymium, Yttrium, Ytternium, Scandium, Erbium, Terbium.

Other Hand-Books and Treatises

Abegg's "Handbuch der anorganischen Chemie," published 1905-1920, is another standard reference work on inorganic chemistry, and is perhaps better known than Gmelin-Kraut, although it also is incomplete.

Dammer's "Handbuch der anorganischen Chemie" is of similar character, though of earlier date.

Dammer's "Handbuch der Chemischen Technologie," 5 volumes, published 1895-1898, supplemented by "Chemische Technologie der Neuzeit," 3 volumes, 1910-1911, is a valuable survey of applied chemistry.

Roscoe and Schorlemmer's "Treatise of Chemistry," in English, and Moissan's "Traite der Chimie Minerale," in French, are also useful reference works.

General Reference Works, Organic Chemistry

The most valuable work in the field of organic chemistry for use as a digest or reference work is Beilstein's "Handbuch der Organischen Chemie." Every organic chemist who has occasion to make investigations of the literature should be well acquainted with it.

The third edition was published in four volumes, from 1893 to 1899; the four supplemental volumes in 1901 to 1906; the supplemental volumes (Ergänzungsbände) following the same general plan as the original volumes. The fifth supplemental volume or index volume was also published in 1906. The scope of the work will be indicated from the following:

Vol. 1, published 1893, Fatty Series.

Vol. 2, published 1896, Aromatic Series: Hydrocarbons, Phenols, Alcohols, Acids.

Vol. 3, published 1897, Aromatic Series: Aldehydes, Ketones, Quinones, Camphor Products, Terpenes, Ethereal Oils, Resins and Balsams, Glucosides, Bitter and Indifferent Substances, Dyestuffs, Tanning Material, Furane Series (Thiophenbodies), Alkaloids.

Vol. 4, published 1899, Aromatic Series, Bases Azoxy-, Azo-, Hydrazo-, Diazo-, Diazoamino-Derivatives, Albuminates, Phosphorus-, Antimony-, Arsenic-, Bismuth-Compounds, Boron and Silicon Compounds. Metallo-Organic Compounds.

Each volume is provided with an index, but these are superseded by the supplementary Index Volume 5, which gives an elaborate name index of the various compounds of organic chemistry described in the entire work.

Beilstein is supplemented by Richter's "Lexikon der Kohlenstoff-Verbindungen," in four parts, published in 1910-1912. This book is a collective index to the third edition of Beilstein and also contains numerous other literature references covering the period up to and including 1909.

A fourth edition of Beilstein, to consist of fifteen volumes, is being prepared by Bernard Prager and Paul Jacobson.[2] The volumes which have appeared to date are:

Vol. 1, published 1918, Acyclic Hydrocarbons, Hydroxy- and Carbonyl-Compounds.

Vol. 2, published 1920, Acyclic Carboxylic Acids.

Vol. 3, published 1921, Hydroxy- and Carbonyl-Carboxylic Acids.

This fourth edition is to include the literature up to the end of the year 1909.

Subsequent to 1909, Stelzner's "Literatur-Register der Organischen Chemie" covers the literature of organic chemistry for the period of 1910-1911 (vol. 1) and 1912-1913 (vol. 2).

Another index which should be mentioned in this connection is the card index catalog of the Patent Office at Washington. This catalog, so far as it relates to organic chemistry, has a system of classification by formula very similar to that of Richter's "Lexikon." This card index is not, of course, available except at Washington. It has been compiled under the direction of Dr. Edwin A. Hill, of the Classification Division of the Patent Office, and its character and scope are described in articles by Dr. Hill appearing in the *Journal* of the American Chemical Society, vol. 2, year 1900, pages 478-494; vol. 29, year 1907, pages 936-941; and vol. 34, year 1912, pages 416-418. It is also described in Appendix K of the report of the investigation of the United States Patent Office made by the President's Commission on Economy and Efficiency in 1912 (House of Representatives Document 1100, Sixty-Second Congress, Third Session).

Bolton—Select Bibliography of Chemistry

Another important work of a bibliographical character is the "Select Bibliography of Chemistry," by Henry C. Bolton, published by the Smithsonian Institution (Smithsonian Miscellaneous Collection Nos. 850, 1170 and 1253).

The first volume of this bibliography was published in 1893 and covers the period from 1492 to 1892. The first supplement, published in 1899, covers the period from 1492 to 1897, and includes works omitted from the first volume, together with those appearing up to the end of the year 1897. The character of this bibliography will be apparent from the following quotations from the preface of the first volume:

> An attempt has been made in the following pages to collect the titles of the principal books on chemistry published in Europe and America from the rise of the literature to the close of the year 1892. The term chemistry is taken in its fullest significance, and the Bibliography will be found to contain books in every department of chemical literature, pure and applied;
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> * * * * * * *
>
> The Bibliography is confined, however, to independent works and their translations, and does not, as a rule, include Academic Dissertations (which are so numerous as to require a special catalogue), nor so-called "reprints" or "separates" (Separate-Abdrücke); of the latter only a few score are ordinarily printed and they must be regarded as belonging to periodicals. No attempt has been made to index the voluminous literature of periodicals except in the section of Biography as noted below.
>
> * * * * * * *
>
> To facilitate reference the work is divided into seven sections: I, Bibliography; II, Dictionaries; III, History; IV, Biography; V, Chemistry, pure and applied; VI, Alchemy, VII, Periodicals.

Altogether the first volume contains about twelve thousand titles, while the first supplement has fifty-five hundred more, making more than 17,500 in all. Of these titles 273 of the first volume and 95 of the supplement relate to bibliographies, while 327 of the first volume and 84 of the supplement relate to dictionaries and tables.

The third volume of this "Select Bibliography of Chemistry," by Bolton, relates to "Academic Dissertations." The dissertations are indexed under the authors' names, but the book is also provided with a subject-matter index. The nature of the work will be apparent from the following extracts from page 3:

> This bibliography is not an index to the chemical dissertations that have appeared in periodicals, but a list of those that have been printed independently. When compiling the list of titles I was fortunate in securing permission to make copies of the card catalogues of two large collections of dissertations on chemistry, those in University Library, Strassburg, and those in the library of the United States Geological Survey, Washington City. I had also the opportunity of cataloguing several thousand dissertations deposited by the Smithsonian Institution in the Library of Congress; the latter were chiefly of German origin.
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> * * * * * * * *
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> For the convenience of residents of the United States the dissertations found in the libraries of the Geological Survey and of the Smithsonian Institution are indicated by the letters "G. S." and "S. I." respectively.

Catalog of Scientific Papers

This work, which is still incomplete, has been compiled and published by the Royal Society of London. It has properly been referred to as the most comprehensive index to general science ever attempted. The first six volumes, published 1867-1872, cover the period from 1800 to 1863. In the preface of vol. 1, it is said:

> This catalog is intended to serve as an index to the titles and dates of scientific papers contained in the Transactions of societies, journals and other periodical works which have been published from the beginning of the present century to the end of the year 1863.

In the introduction of this same volume the subject-matter of the catalog is discussed in part as follows:

> The following catalog is intended to contain the title of every scientific memoir which appears in the various Transactions and Proceedings of scientific societies, and in the scientific journals published within the time which it comprehends; with the reference, the date, the author's name and the number of pages in the memoir.
>
> * * * * * * * *
>
> A list of the works indexed, nearly fourteen hundred in number, arranged alphabetically according to the contraction employed in the catalog, will be found at the end of the introduction.
>
> * * * * * * * *
>
> The titles are arranged alphabetically according to

[2]For a discussion of the arrangement of compounds in this new edition see "Classifying Organic Compounds by the Prager-Jacobson System," by Donald W. MacArdle, CHEM & MET. ENG., vol. 22, p. 256, Feb. 11, 1920.

the authors' names, the arrangement under the head of any one author being chronological.

The second series of the catalog, vols. 7 and 8, published 1877-1879, covers the period from 1864 to 1873. The third series, in three volumes (9 to 11), published 1891-1896, covers the period from 1874 to 1893. A supplementary volume, vol. 12, published in 1902, contains additional papers published between 1800 and 1883.

The papers of this supplementary volume were taken from more than 350 added periodicals, so that, with the nearly 1,400 periodicals indexed in the first volume, and with the 130 more added in vol. 6, the total number of periodicals indexed in the "Catalog of Scientific Papers" up to 1883 is between eighteen and nineteen hundred.

The fourth series of the catalog covers the period from 1884 to 1900. Vols. 13 to 16, for about half of the papers of the series, have so far been published, although their publication is of comparatively recent date (1914-1918). The remaining volumes are yet to appear.

When the catalog is completed, it will consist of an author catalog and a subject index covering the entire period from 1800 to 1900. That is, the volumes of the author catalog are to be supplemented by index volumes of subject-matter covering the entire period from 1800 to 1900. The subject indexes are to be issued separately for each of the seventeen sciences dealt with in the "International Catalog of Scientific Literature," and will be arranged in accordance with the schedules of the International Catalog. The index volumes of "Pure Mathematics, Mechanics and Physics" have thus far been published. Unfortunately the index volume for chemistry is not yet available. Until this volume is available, the "Catalog of Scientific Papers" cannot be readily searched, except as an author index. However, for investigating the various papers of any given author between the dates 1800 and 1900, the catalog undoubtedly furnishes the most complete and comprehensive single index available. When the subject-matter index volumes are likewise available, it will then be the most complete and one of the most valuable indexes of the chemical literature of the nineteenth century.

International Catalog of Scientific Literature

Beginning with the year 1901, the "International Catalog of Scientific Literature" was published as a continuation of the "Catalog of Scientific Papers" of the Royal Society of London, and it now appears annually, in seventeen volumes, for each of the seventeen sciences dealt with. These sciences or branches which are included in the catalog are as follows:

A. Mathematics.
B. Mechanics.
C. Physics.
D. Chemistry.
E. Astronomy.
F. Meteorology (including Terrestrial Magnetism).
G. Mineralogy (including Petrology and Crystallography).
H. Geology.
J. Geography (Mathematical and Physical).
K. Palæontology.
L. General Biology.
M. Botany.
N. Zoology.
O. Human Anatomy.
P. Physical Anthropology.
Q. Physiology (including experimental Psychology, Pharmocology and experimental Pathology).
R. Bacteriology.

In the list of the journals, published as a separate volume in 1903, the surprising number of 4,673 journals is listed from twenty-five different countries. Germany leads with 1,308, France is second with 919, the United States third with 539, and the United Kingdom fourth with 455, while Russia is fifth with 397.

It is, of course, evident that the field covered by the international catalog, as well as that covered by the "Catalog of Scientific Papers," is much broader than chemistry, but inasmuch as a separate volume appears annually for each science, the consideration of the portion of the catalog relating to chemistry does not involve a consideration of the portions of the catalog relating to other sciences. The "International Catalog" is one of the most valuable indexes of the chemical literature for the period which it covers (since 1900).

Repertorium der Technischen Journal Literatur

This work goes back to 1823, was edited by Schubarth for the volume covering the period 1823 to 1853, and by Kerl for the two volumes covering the periods 1854 to 1868 and 1869 to 1873. Beginning 1874 it appeared annually, and since 1877 it has been published by the German patent office. Prior to 1879 it was known as the "Repertorium der Technischen Literatur"; since 1879 it has been known as the "Repertorium der Technischen Journal Literatur."

It has had an author index since 1897 in addition to the subject index which it has always contained. The last volume of the "Repertorium" was published in 1908.

The general arrangement of the "Repertorium" is alphabetical, by subjects, and it contains reference to a large number of the leading articles appearing both in the German and in other periodicals for the current year. The field covered includes much that has no relation to chemistry and metallurgy, but it is nevertheless a valuable index for use in searches of the chemical and metallurgical literature. It is of course equally valuable in other fields than chemistry.

The Industrial Arts Index

This index is published by the H. W. Wilson Co., 958-964 University Ave., New York. The plan of the index is set forth by the publishers in the following language:

> The Industrial Arts Index is an indexing service to eighty-one technical journals which have been selected by our subscribers as the leaders in their respective fields. It reaches you in magazine form (instead of loose cards) ten times a year. The entries are arranged alphabetically by subject and repeated under place names when necessary. Every article of importance in these eighty-one magazines is indexed under as many subject headings as will bring out all points of interest, and cross-references direct to the searcher of allied subjects in other parts of the alphabet.
> The rate for this service is based on the number of periodicals indexed for which you subscribe.

Annual volumes of the index have been published since 1912.

This index is not comparable with *Chemical Abstracts*, either in the scope of the field covered or in the detailed information which it gives, but it is nevertheless a useful index for many purposes, and one with which the searcher should be familiar. It includes much that is of general interest which is outside the field of chemical literature.

Mining World Index

The "Mining World Index" of current literature was published from 1912 through 1916 by the Mining World Co. of Chicago. It was edited by the editor of the *Mining and Engineering World* and was published as "An International Bibliography of Mining and the Mining Sciences, compiled and revised semi-annually from the

index of the World's Current Literature, appearing weekly in *Mining and Engineering World.*"

This index is of more particular interest to those making investigations of the mining and metallurgical literature, for the period which the index covers (i.e., 1912 to 1916).

Engineering Index

The "Engineering Index" is an index which is likewise of more particular interest in connection with technical and engineering subjects, but it will nevertheless in some cases be found useful in those branches of applied chemistry which are included within its scope. Four volumes of the index cover the period from 1884 to 1905, and annual indexes have since been published. In 1906 the index covered about 250 technical and engineering journals in six different languages, about one-fourth of the periodicals indexed being in languages other than English.

Part II will be published in a subsequent issue.

British Report on Use of Tidal Power

In its third interim report to the President of the [government] Board of Trade the Water Power Resources Committee—of which Sir John Snell is chairman—deals solely with the question of utilizing the tides for power purposes. Its object is to urge the need of a more detailed technical inquiry into the subject than the committee itself is in a position to undertake. Of the tidal power schemes brought to its notice the greater number show no recognition of the very serious technical difficulties involved in harnessing the tides, and few have been worked out in detail. The committee has, however, had under consideration two tidal power schemes for the Severn Estuary, which, although preliminary, were based on investigation of the actual conditions of the site and were accompanied by estimates of cost.

The possibility of utilizing the tides of the Severn may almost be regarded as a test question; the tidal amplitude is large, the configuration of the estuary is well suited to the purpose; the physical characteristics of the land in the vicinity are such as to facilitate the construction of a high-level storage reservoir; and the adjoining industrial district is one in which the power requirements are already large, and the power supply is likely to be absorbed completely for industrial purposes.

Preliminary Examination Made

As a safeguard against undue optimism, the committee thought it desirable to carry out an independent preliminary examination of the subject on broad lines. A subcommittee consisting of Sir Philip Dawson and Prof. A. H. Gibson was constituted for this purpose. This subcommittee approached several of the leading firms of manufacturers of turbines and electric generators throughout the world with the object of obtaining particulars concerning low-head and variable-head turbines and electric generators suitable for tidal power schemes to enable it to frame an estimate of the possibility of utilizing the tides of the Severn. The results of the investigations which have been carried out support the view that energy can be generated and utilized at a favorable rate.

After giving careful consideration to the views expressed by the subcommittee the main committee finds that while on the information before it it is not in a position to recommend the Severn scheme as a practical proposition, it is in unanimous agreement that the plan certainly cannot be dismissed as impracticable, and that further and more detailed technical inquiry into the subject of tidal power is amply justified and should be initiated without delay.

The utilization of tidal power involves the solution of many complex problems, and though the committee is of the opinion that a prima facie case has been made out for the Severn scheme, it must be pointed out that before a final pronouncement is possible a further investigation of a number of physical and technical questions—some of general interest and some peculiar to the conditions of the Severn—must be made.

Summary of Conclusions and Recommendations

The conclusions arrived at are:

The difficulties to be overcome in harnessing the tides are so bound up with local conditions that it is essential that the general question of tidal power should be approached with reference to actual conditions obtaining at the same particular locality.

The technical information available in regard to the possibility of utilizing the tides in the Severn for the generation of power is not sufficiently precise to enable the committee to express a final opinion on the schemes which have been brought before it.

Preliminary estimates indicate, however, that if the Severn tides were used energy could be generated and utilized at a favorable rate, and that the power obtainable throughout an industrial day of ten hours would be of the order of 260,000 kw. and the consequent saving of coal would be from one and one-fourth to two and one-half million tons annually.

The committee recommends that:

The Board of Trade, in consultation with the Minister of Transport, should set up a special technical commission, consisting mainly of expert engineers and persons of scientific attainments, to investigate the possibility, from a commercial standpoint, of utilizing the tides for power purposes.

The inquiry should be pursued with special reference to the Severn Estuary; the commission should prepare a preliminary design and reasonably detailed estimates of cost of a tidal power scheme for that estuary, taking into consideration the desirability of making provision for road, railway and shipping facilities suited to the requirements and possibilities of the adjoining district.

The commission should have regard to any interests likely to be detrimentally affected and should consider and report upon the steps which might be taken to prevent or mitigate injury to any interest.

United States Sugar Production, 1920

According to a preliminary estimate made by the Department of Agriculture, beet sugar production in 1920 exceeded the former record crop of 1915 by 27 per cent and reached the figure of 2,219,200,000 lb. Production of cane sugar is estimated to have been 385,974,000 lb., so the total estimated sugar crop for United States was 2,605,174,000 lb. This was 15 per cent above record sugar production in 1916 and 53 per cent above 1919.

The sugar produced within the United States amounts to about one-quarter of the total consumption, which is estimated as 9,750,000,000 lb. for 1920, equivalent to 92 lb. per capita.

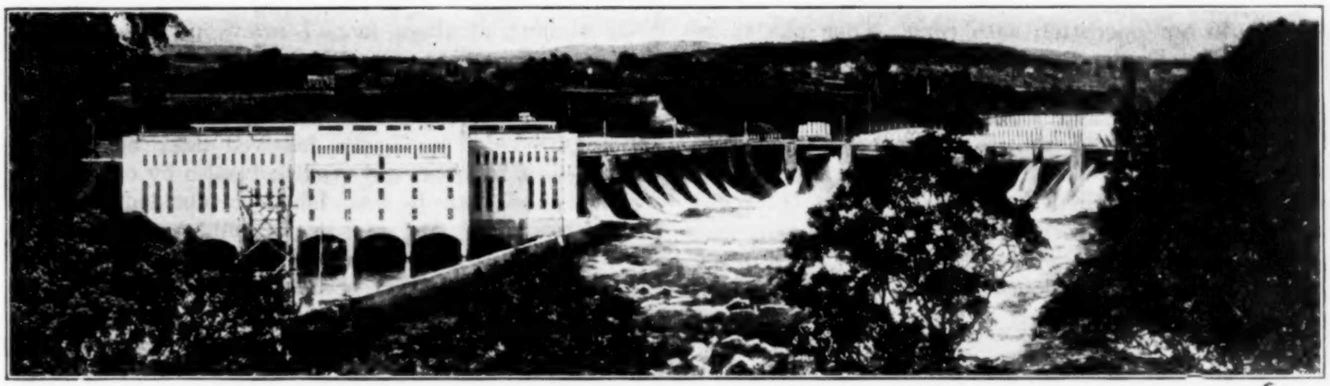


FIG. 1. BULLERFORSEN ELECTRIC POWER PLANT
Mounted for 24,000 hp. normal and 30,000 hp. maximal load.

Electric Smelting of Pig Iron at Domnarfvet, Sweden

Early Operation at the Domnarfvet Iron Works and Conditions Leading to the Adoption of Electric Furnaces—Possibilities of Using Non-Charcoal Reducing Agents and Pit Instead of Shaft Furnaces Are Still in the Research Stage

BY BARON GERARD DE GEER
Manager, Domnarfvet Steel Works

STORA Kopparbergs Bergslags Aktiebolag, the company owning the Domnarfvet Iron Works, is the oldest in Sweden and most probably one of the oldest in the world. It has been estimated that the company was established about 1225, and there are still certain documents in existence, photographs of one of them being given in Fig. 2, setting forth special rights which had been granted the company by Swedish kings in the thirteenth century. At first, the smelting of copper at the Falun mine ("Stora Kopparberget," or the great copper mountain) was the main source of revenue, but during the following centuries iron and steel were also produced in increasing quantities. This industry was, as was the case with the iron industry of Sweden in general, based on the production of high-quality materials and was carried on at a great number of small plants. When railways had been built and the transportation conditions completely changed, these small places were concentrated to a large and more up-to-date plant, the Domnarfvet Iron Works.

EARLY OPERATIONS AT DOMNARFVET

This plant was built at the intersection of the Dal River and the railway which connects the works with its iron ores, as well as with Gothenburg, the most important harbor for import and export in Sweden. Wood required for making charcoal is transported in rafts on the Dal River, around the upper course of which the company's extensive forests are situated. Also power is obtained from the Dal River, which not far from Domnarfvet forms several important waterfalls (Fig. 1).

To begin with, the plant, in the same way as its predecessors, was intended for the manufacture of high-quality materials for export, but later the production was changed to ordinary iron for domestic consumption. There were several reasons for this. As Sweden became an industrial country, the demand for ordinary iron had increased and as certain grades were protected by tariff, the conditions for domestic manufacture became more favorable. Moreover, it had become possible to use high-phosphorus ores in the basic steel processes invented at the end of the last century. Stora Kopparbergs Bergslags Aktiebolag is the owner of great deposits of very rich and suitably situated ore of this kind, which had heretofore been regarded as nearly valueless. Domnarfvet was therefore rebuilt, with the object in view to enter the domestic market and also to utilize the company's cheap high-phosphorus ores.

A basic bessemer plant was built with four 10-ton converters, and also a basic open-hearth plant with four 25- to 35-ton furnaces as shown on the plan, Fig. 3. As it was not possible to produce the required amount of pig iron in the original charcoal blast furnaces, these

FIG. 2. THE OLDEST ORIGINAL PURCHASE DEED CONCERNING STORA KOPPARBERGET
Issued by the bishop Peter Elofsson, June 16, 1288, and relating to one-eighth of the company.

were rebuilt for operation with coke. Coke had to be imported from England or Germany, and was always of a poor quality on account of the long transportation and the frequent loading and unloading. We were equipped with reversing cogging mill, rail and shape mill, sheet and tin plate mills, wire mills and various merchant mills. With this equipment, the capacity of the plant was about 100,000 tons rolled products per year.

It soon became evident that this output was far too small and in nowise corresponded either to the selling possibilities or to the modern demand for mass production. When contemplating further construction, however, the question of obtaining fuel became vital. The plant had cheap ore and power, but the expensive and inferior coke was a real handicap in the competition with the imported iron. At this time (about 1910), electric pig iron smelting began to give commercial promise, so the company decided to postpone its new construction until it had been shown whether the increased requirement of pig iron could not be met by producing it with electric heat. This was thought to be well within the range of possibility, as the company could develop cheaply about 160,000 kw.

In order to decide this question, one 3,000-kw. shaft furnace of the Electrometals type and one 9,000-kw. Helfenstein furnace were built at Domnarfvet. The latter was a modified ferrosilicon furnace without a shaft. At about the same time the widely reported tests at Trollhättan were made with an Electrometals furnace, in which experiments all the iron works of Sweden were financially interested. After a few years' experimenting, it became evident that electric pig iron could easily compete with the Swedish high quality iron produced with charcoal, but not with ordinary iron produced in large quantities and that shaft furnaces were the most suitable, open furnaces being not as economical, as for instance when producing ferro-alloys.

On account of these facts Stora Kopparbergs Bergslag decided in 1914 to continue producing chiefly coke pig iron at Domnarfvet, and to built immediately a modern blast furnace with a daily capacity of about 500 tons. This was to be followed later by another similar blast furnace, and eventually also by coke ovens. At the same time it was, however, decided that the electric production of pig iron should not be discontinued, but kept up and further developed, as far as the supply of cheap power warranted. As the flow of water in the Dal River is considerably above normal during five or six months of the year, power can be obtained during this period at a very low price. The manufacture of steel would still be based on the basic bessemer process and the open-hearth plant was to be increased in capacity to take care of the increased amount of scrap. In these plans, the possibility of refining the basic bessemer metal in electric steel furnaces to improve its quality was also considered.

Coke Shortage Drives Plant to Electric Furnaces

Construction of the new coke blast furnace was started immediately and at the same time some extensions were made to the melting and rolling shops to enable them to handle the increased quantity of iron. At this time, however, the world war broke out and upset all the calculations. The price of coke rose to an undreamed-of height, and at times it was impossible to obtain coke at all. As a matter of fact since 1917 the purchase price of one ton of coke has been higher than the cost to produce one ton of electric pig iron. To continue producing coke pig iron under such conditions was evidently impossible. At first we tried to mix coke and charcoal, but after a while the coke furnaces had to be shut down. Domnarfvet came to be in a very precarious condition, as it was impossible to obtain the pig iron required to keep the plant in operation. Still

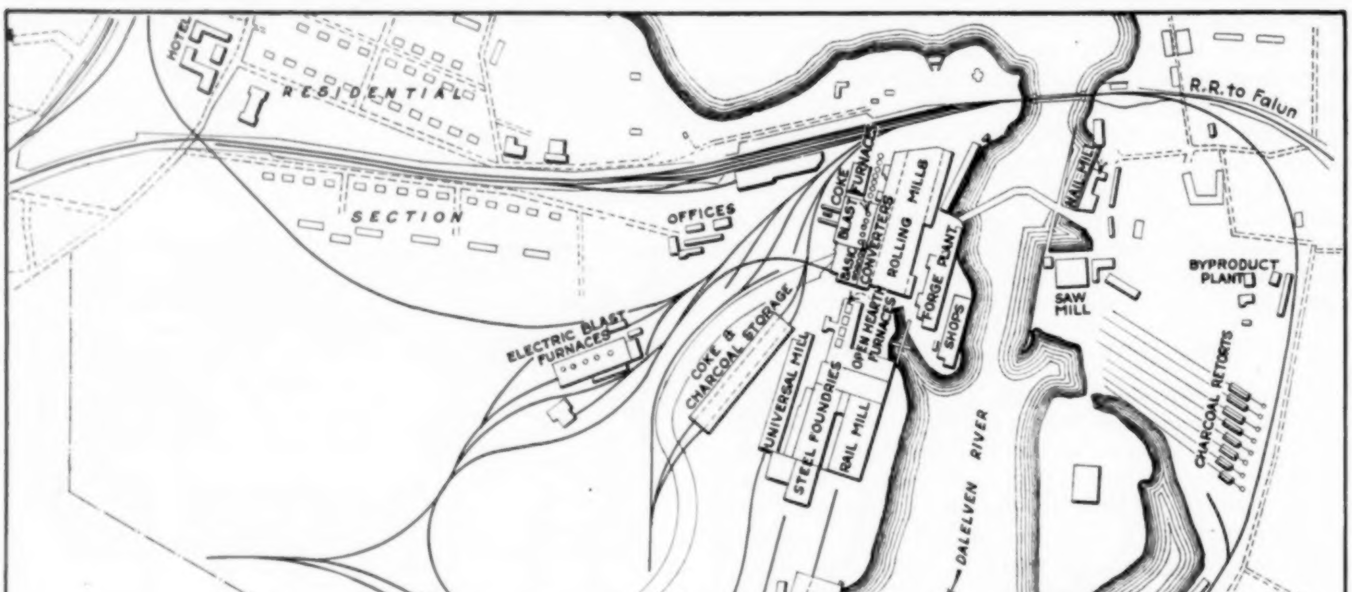


FIG. 3. MAP OF DOMNARFVET STEEL WORKS

worse, the conclusion of peace and conditions following this did not improve the situation. There is no open market for coal and coke in Europe and everything indicates a permanent high price of coke.

Through these changed conditions the situation as regards coke iron and electric pig iron has become such as to give the latter a decided advantage. The only road open for Domnarfvet, not considering the alternative of shutting down completely, was to increase the production of electric pig iron. The construction of the new coke blast furnace, the foundations, storage yards and machinery of which were already finished, had to be stopped, and the installation of the electric furnaces hastened instead. However, water power must also be developed, which requires considerable time and capital.

In order to be able to increase the ingot production sooner, it has also been decided to install electric steel furnaces for melting cold scrap. Such a furnace, of 10 tons capacity, was finished in 1920 and two more were put in course of construction.

The electric pig iron process differs from the ordinary process, as is well known, in that the fuel required to heat and melt the charge is substituted by electric energy. In an electric pig iron furnace, only that quantity of charcoal is charged as is required for the reduction of the ore. As no air is blown in, the combustion of the carbon must be effected by means of the oxygen in the ore. The differences in design and operation between a blast furnace and an electric pig iron furnace are due to these conditions.

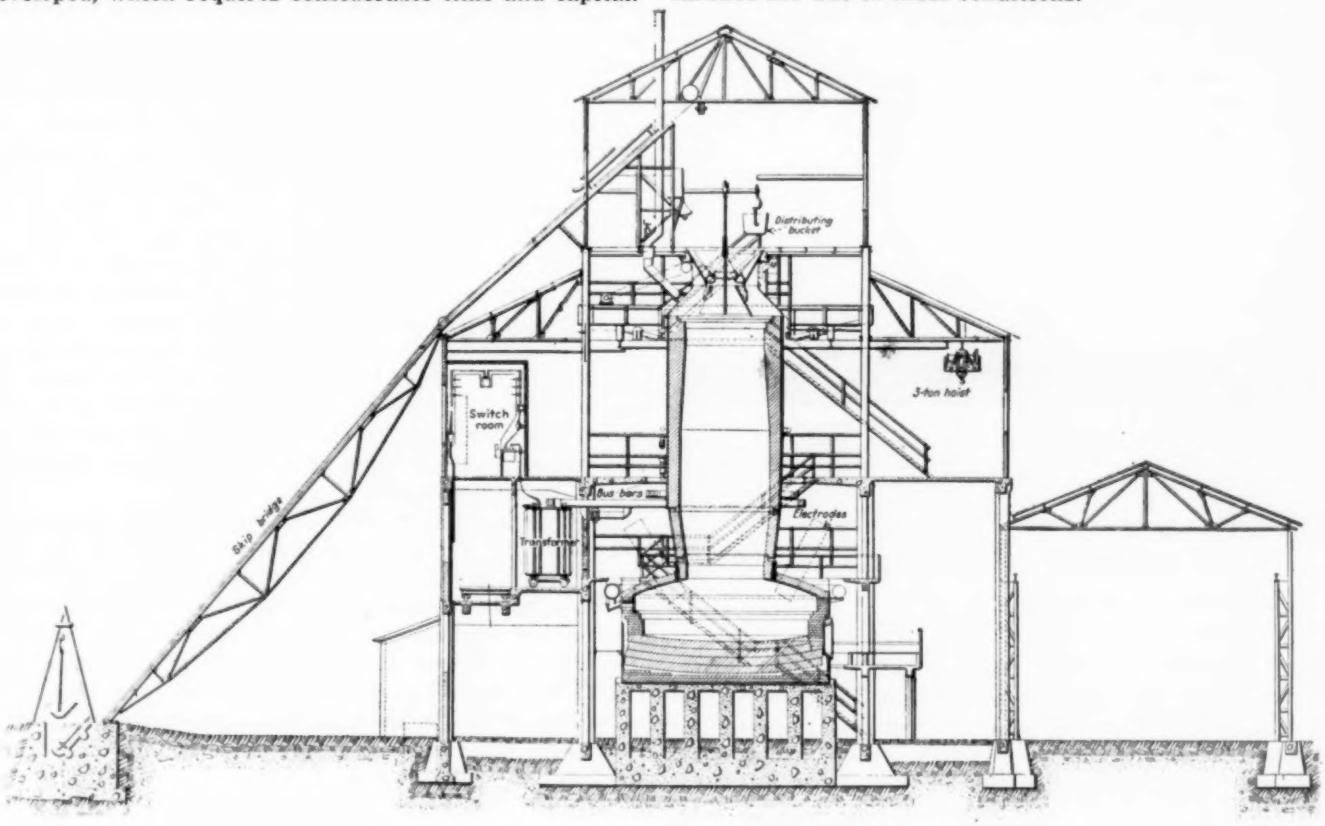


FIG. 4. CROSS-SECTION OF ELECTRIC PIG-IRON FURNACE PLANT

At the present time, six electric pig iron furnaces are built or are in the course of construction. The year of construction, type and capacity are given below:

Assuming an output of 3.6 tons pig iron per kw-yr., the capacity of the Electrometals furnaces would correspond to an output of about 80,000 tons per year. Such

Year	Type	Condition	Nominal Capacity of Transformers,* Kw.
1911	Electrometals	....	3,000
1912	Helfenstein	Not operating in 1920.........	9,000
1915	Electrometals	....	5,500
1918	Electrometals	....	4,000
1919	Electrometals	....	4,500
1920	Electrometals	Building in 1920.............	5,000
			31,000

* Variation in these figures as quoted in the literature at various times and places is due to using figures purporting either the maximum or average input into the furnace, measured at different points.

an output, however, cannot be attained, as the supply of water allows full load only during certain periods.

A regulation of the drainage system of the Dal River by storing the water in the spring and autumn floods in the lakes to bring about a more uniform supply of power has already been started.

Fig. 4 shows furnace No. 4 at Domnarfvet. The upper part is similar to a blast furnace, but the lower part consists of a large crucible, the walls of which are connected with the shaft by means of a circular roof. Through this roof four, six or eight electrodes are inserted; they have a diameter of 600 to 700 mm. Gas is taken off at the top under the charging platform, cleaned in the usual manner, and part of it is blown into the furnace again through openings, as shown in the drawing, between the electrodes and immediately under the roof. A certain quantity of gas is therefore always circulating in the furnace.

The gas circulation is of very great importance for the proper operation of the furnace and attempts to dispense with it have failed. The gas cools the roof, thereby increasing its life, and also distributes the heat and the chemical reactions more evenly between the hearth and the shaft. The evolution of gas in an electric furnace is naturally considerably less than in a blast furnace, where about three times as large a quantity of carbon is burnt. The heat carried by the gas from the hearth up the shaft, as well as its ability

to perform the chemical reactions, will therefore be less. This is counterbalanced by blowing gas into the furnace. The carbon dioxide of this gas is immediately split up, forming carbon monoxide, which higher up in the shaft again unites with oxygen of the ore.

Precautions for Successful Operation

In connection with an electric pig iron furnace, there are several factors which must be taken into consideration, but which are of no consequence in a blast furnace. The operation is very sensitive and requires careful attention, a fact perhaps better illustrated by a short account of some of the more common operating troubles.

It is of the utmost importance that the amount of carbon charged is carefully adjusted to the oxygen in the ore. If too much carbon is charged, the excess can not be burned, but accumulates in the hearth, causing "hot runs" with their accompanying troubles. If, on the other hand, insufficient carbon is charged, the reduction will be incomplete. The slag will be dark with a high content of iron and the furnace will run cold. Disturbances of the state of equilibrium between carbon and oxygen may be caused either by variations in the composition of the charge or, which is more common, by variations in the carbon dioxide content of the gas. The ratio $CO_2 : CO$ is, as in a blast furnace, influenced by several factors, as for instance the temperature, the pressure, the size of the charcoal, etc. Assuming that the run is otherwise satisfactory, if this ratio is changed so that CO_2 is increased, there will be an excess of carbon burned up in the hearth. The amount of carbon charged is the same, but a certain part of this carbon will unite with more oxygen than before, and consequently a residue of carbon is obtained which cannot be burned. By accumulations of carbon in the hearth, the space required for the reactions becomes smaller, the temperature increases, and the rate of melting decreases. This causes the CO_2 content to increase still more and conditions become still worse. Finally, the zone of reaction will come up close to the shaft and the energy put into the furnace will not cover the losses. The furnace will then come to a standstill.

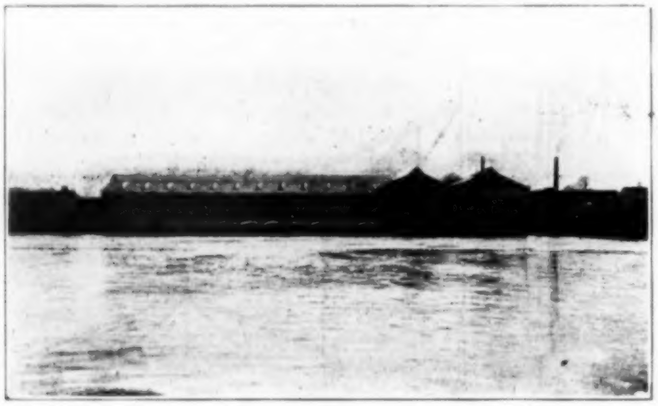


FIG. 5. DOMNARFVET STEEL WORKS
The new rolling mill plant.

If for some reason the ratio $CO_2 : CO$ is changed so that CO_2 is decreased, the conditions will be just the opposite. The rate of melting will increase, the pig iron will become cold, and the slag will be very unsatisfactory. Also in this case a minor disturbance will show a tendency to multiply itself, due to the fact that the increased rate of melting causes the percentage of CO_2 to decrease still more.

The problem of overcoming these troubles presented a good deal of difficulty at the start. This was particularly the case with hot runs with an excess of carbon in the hearth. To decrease the carbon or to increase the ore, as would be done in a blast furnace, proved to be ineffective. It was difficult to make the proper adjustment, and, through the decreased rate of melting, it took a long time before any change in the charge could make itself felt in the hearth. Frequently it was only a temporary disturbance which caused the trouble, and if the charge was changed permanently, it might cause the furnace to change from one extremity to the other. While adjusting the operation in this way, the equilibrium of the furnace proved to be very unstable and during long periods hot runs might change to cold runs and *vice versa*, with excess or want of carbon in the hearth.

The simplest way to correct hot runs for instance would be to charge a certain quantity of ore directly into the hearth, corresponding to the excess of carbon. It has also been suggested to combat it by sprinkling water on the charge through the gas intakes. Both these methods have been tried, but they are difficult of application. It has been found that the best way to restore equilibrium between carbon and oxygen is to add only one or two charges of ore or charcoal without making any permanent change in the burden. This is changed only when the furnace shows a decided tendency to run hot or cold. It would of course be better to prevent the disturbances altogether, and it is advisable to observe carefully the composition of the gas and at the first sign of departure from normal limits make the necessary adjustments.

Another peculiarity with the electric shaft furnace is the difficulty of regulating the temperature of the pig iron when the furnace is running normally. An increase in the amperage does not increase the temperature of the iron tapped, but only increases the rate of melting. It is true that an increase of carbon in the charge will make hotter iron, but at the same time, due to excess carbon in the hearth, it will cause grave disturbances. It seems that pig iron attains only that temperature which is necessary for the reactions in the hearth to take place. The superheating desirable to avoid losses in runners and skulls during tapping and transportation of the iron is often very difficult to obtain.

Operating Data

In the accompanying table is a tabulation of analyses of raw materials and products at the electric furnaces at Domnarfvet together with some operating data.

The ore is taken from Grängesberg deposits and is a mixture of magnetite and specular hematite. Phosphorus analyzes about 1 per cent, somewhat too low to obtain the desired content of phosphorus in the pig iron. Some apatite is therefore generally added, also some manganese ore or slag high in manganese to raise the manganese content. As the ore, as well as the charcoal, is practically free from sulphur, and the silica content of the ore is relatively low, only a small amount of limestone is needed as addition to the charge in order to obtain the desired composition of the slag, which in turn is used for the manufacture of cement.

Gas from electric furnaces is considerably richer than ordinary blast-furnace gas and is an appreciable item on the credit side of the electric furnace account. The excess of gas has been estimated at 400 to 600 cu.m. per ton of pig iron. At Domnarfvet it is used for

OPERATING DATA AT DOMNARFVET

	Iron Ore	Slag
Fe_3O_4	64.96 (Fe = 61.49)	.....
Fe_2O_3	20.64	.....
FeO	.....	0.87 (Fe = 0.68)
MnO	0.19	0.96
MgO	1.79	12.57
CaO	4.00	38.83
Al_2O_3	2.00	12.06
SiO_2	4.20	32.82
P_2O_5	2.40 (P = 1.05)	0.64

Pig Iron,		Gas	
C	3.6 –4.0%	CO_2	25%
Si	0.5%	CO	65%
Mn	0.75%	H	8.5%
S	0.02–0.015%	N	1.5%
P	1.8 –2.15%		

Materials required per ton of pig iron:

Iron ore, kg	1,720
Limestone, kg	60
Charcoal, kg	370
Power, kw.-hr	2,400
Electrodes, kg	8

ing limestone or, mixed with producer gas, in open-hearth furnaces. On account of its high content of carbon monoxide, this gas is very poisonous and great care must be exercised to guard against leaks in the tanks and piping.

Non-Charcoal Reducing Agents

A question which is of vital importance for the future of the electric pig iron furnaces is the possibility of using some other reducing agent than charcoal. If the electric iron industry at Domnarfvet is to be further developed, its maximum capacity will be determined by the supply of charcoal, not of power, since supply of the former will give out sooner than the supply of the latter. On account of the much increased demand for paper and paper pulp, the competition for wood for making charcoal has become very active. The prices threaten to increase so as to make the manufacture of charcoal prohibitive and the charcoal ovens will soon be run only on wood refuse.

If the utility of the electric pig iron process in Sweden is to be limited by the amount of charcoal available, it will be so much more circumscribed in other countries which have a large supply of water power but lack charcoal. Other reducing agents which may be considered are coke and anthracite.

Tests with coke have been made at Domnarfvet. It was shown that a mixture of coke and charcoal, with 50 per cent of each, could be used without causing trouble, but when a higher percentage of coke, or coke alone was used, the results obtained were poor. The output decreased considerably and the power consumption per ton of pig iron increased. This fact may be explained by the comparatively low electric resistance and high density of coke as compared with charcoal, resulting in decreased velocity of reaction. Another inconvenience consisted in the tendency of the coke to graphitize at the high temperature prevailing around the arcs. Graphitized coke reacts only very slowly with the oxygen in the ore. Hot runs, with accompanying evils, became on account of this still worse, as once an excess of carbon was obtained it was difficult to burn. Actual tests with coke at the Domnarfvet electric furnaces have definitely proved this fact, that the troubles on account of hot runs were considerably greater when running with coke than with charcoal.

With this exception, there were no technical difficulties in connection with operation with coke, but our economical results were poor on account of the lowered production and the increased power consumption. To

FIG. 6. DOMNARFVET STEEL WORKS
Houses for Workmen

pronounce the Electrometals furnaces as unsuitable for operation with coke or anthracite on account of these tests would be incorrect. Domnarfvet furnaces were designed in view of operation with charcoal exclusively and it is evident that operation with coke requires a somewhat different design, as is the case with blast furnaces. What this difference is is not yet determined, at least not on the basis of actual tests. An answer to this question will doubtless be had in the near future, as it is said that plans to try out coke are maturing at several places.

Pit Versus Shaft Furnaces

Another interesting question in connection with electric smelting or ore is the possibility of using simpler and cheaper furnaces than the relatively complicated shaft furnaces, such as the open furnace of about the same type that is used for making ferrosilicon. Although tests with this kind of furnace considerably antedated the tests with shaft furnaces, these latter furnaces have been successfully developed, while the open furnaces have not yet passed the experimental stage. It might be justly asked why pig iron cannot be made in an open furnace as well as ferrosilicon, which is more difficult to reduce. The answer is that technically there is no difficulty in making iron in an open furnace, but economically it is more advantageous to make it in a shaft furnace. Under normal conditions—i.e., with low fuel prices—the difference in the cost of production between blast-furnace iron and electric pig iron is so small that only a very small difference in favor of the former will make the latter impossible. In an open furnace, the consumption of charcoal and power are both greater than in a shaft furnace. The lower temperature of the escaping gases and their higher CO_2 content mean a more effective utilization of power as well as of charcoal. In addition, the excess gas may be used for generating power or heat, something which is done at all large electric pig iron plants. Against these advantages, the open furnace can show a lower cost of installation and possibly a certain adaptation for a variation in the grade of iron produced. Such a furnace may for instance without any difficulty be made to produce pig iron instead of ferrosilicon. However, the possibilities may be of great practical importance in isolated cases.

Domnarfvet is probably one of the few plants where both types of furnaces have been run at the same time on a large scale. The tests were decidedly in favor of the shaft furnaces, and future installations would on that basis probably be made made along the same general lines.

Interconversion Tables and Chart for Units of Volume and Weight, and Energy

MULTIPLY BY

TO CONVERT FROM	To Cu. In.	To Cu. Ft.	To Cu. Yd.	To Fl. Oz.	To Pint	To Quart	To Gallon	To Grain	To Oz. Troy	To Oz. Av.	To Lb. Troy	To Lb. Av.	To CC. or G.	To Ltr. or Kg.	To Cu. M.
Cu. in.	1.00000	.0$_3$5787	.0$_4$2143	.554112	.034632	.017316	.004329	252.891	.526857	.578037	.043905	.036127	16.3871	.016387	.0$_4$1639
Cu. Ft.	1728.00	1.00000	.037037	957.505	59.8442	29.9221	7.48052	436996	910.408	998.848	75.8674	62.4280	28316.9	28.3169	.028317
Cu. Yd.	46656.0	27.0000	1.00000	25852.6	1615.79	807.896	201.974	117990$_2$	24581.0	26968.9	2048.42	1685.56	764556	764.556	.764556
Fl. Oz.	1.80469	.001044	.0$_4$3868	1.00000	.062500	.031250	.007813	456.390	.950813	1.04318	.079234	.065199	29.5736	.029573	.0$_4$2957
Pint	28.8750	.016710	.0$_3$6189	16.0000	1.00000	.500000	.125000	7302.23	15.2130	16.6908	1.26775	1.04318	473.177	.473177	.0$_3$4732
Quart	57.7500	.033420	.001238	32.0000	2.00000	1.00000	.250000	1460.45	30.4260	33.3816	2.53550	2.08635	946.354	.946354	.0$_3$9463
Gallon	231.000	.133681	.004951	128.000	8.00000	4.00000	1.00000	58417.9	121.704	133.527	10.1420	8.34541	3785.42	3.78542	.003785
Grain	.003954	.0$_5$2288	.0$_7$8475	.002191	.0$_3$1369	.0$_4$6850	.0$_4$1712	1.00000	.002083	.002286	.0$_3$1736	.0$_3$1428	.064799	.0$_4$6479	.0$_7$6479
Oz. Troy	1.89805	.001098	.0$_4$4068	1.05173	.065733	.032867	.008217	480.000	1.00000	1.09714	.083333	.068571	31.1035	.031104	.0$_4$3110
Oz. Av.	1.72999	.001001	.0$_4$3708	.958608	.059913	.029957	.007489	437.500	.911457	1.00000	.075955	.062500	28.3495	.028350	.0$_4$2835
Lb. Troy	22.7766	.013181	.0$_3$4882	12.6208	.788800	.394400	.098600	5760.00	12.0000	13.1657	1.00000	.822857	373.242	.373242	.0$_3$3732
Lb. Av.	27.6799	.016018	.0$_3$5933	15.3378	.958611	.479306	.119826	7000.00	14.5833	16.0000	1.21528	1.00000	453.593	.453593	.0$_3$4536
CC or Gram	.061024	.0$_4$3531	.0$_5$1308	.033814	.002113	.001057	.0$_3$2642	15.4323	.032151	.035274	.002679	.002205	1.00000	.001000	.000001
Liter or Keg.	61.0237	.035315	.001308	33.8140	2.11337	1.05669	.264172	15432.3	32.1507	35.2739	2.67923	2.20462	1000.00	1.00000	.001000
Cu. M.	61023.7	35.3146	1.30795	33814.0	2113.37	1056.69	264.172	154320$_2$	32150.7	35273.9	2679.23	2204.62	1000000	1000.00	1.00000

Note. The small subnumeral following a zero indicates that the zero is to be taken that number of times; thus, .0$_3$1428 is equivalent to .0001428.

Values used in constructing table:
1 inch = 2.540001 cm.
∴ 1 cu. in. = 16,387083 cc. = 16.387083 g H_2O at 4°C. = 39°F.

1 lb. av. = 453.5926 g.
∴ 1 gal. = 8.34541 lb.
∴ 1 lb. av. = 27.679886 cu. in. H_2O at 4°C.

1 lb. av. = 7000 grains.
∴ 1 gallon = 58417.87 grains.
231 cu. in. = 1 gallon = 3785.4162 g.

MULTIPLY BY

TO CONVERT FROM	B. T. U.	P. C. U.	Cal.	Ft. Lbs.	Ft. Tons.	Kg. M.	HP Hrs.	KW Hrs.	Joules	Lbs. C	Lbs. H_2O
B. T. U.	1.00000	.555556	.251996	778.000	.389001	107.563	.0$_3$3929	.0$_3$2931	1055.20	.0$_4$6876	.001031
P. C. U.	1.80000	1.00000	45.3593	1400.40	.700202	193.613	.0$_3$7072	.0$_3$5276	1899.36	.0$_3$1238	.001855
Calories	3.96832	2.20462	1.00000	3091.36	1.54368	426.844	.001559	.001163	4187.37	.0$_3$2729	.004089
Ft. Lbs.	.001285	.0$_3$7141	.0$_3$3239	1.00000	.000500	.138255	.0$_6$5050	.0$_6$3767	1.35625	.0$_7$8840	.0$_5$1325
Ft. Tons	2.57069	1.42816	.647804	2000.00	1.00000	276.511	.001010	.0$_3$7535	2712.59	.0$_3$1768	.002649
Kg. M.	.009297	.005165	.002343	7.23301	.003617	1.00000	.0$_5$3653	.0$_5$2725	9.81009	.0$_6$6394	.0$_5$9580
HP Hrs.	2544.99	.141388	641.327	1980000	990.004	273747	1.00000	.746000	2685473	.175044	2.62261
KW Hrs.	3411.57	1895.32	859.702	2654200	1327.10	366959	1.34041	1.00000	3599889	.234648	3.51562
Joules	.0$_3$9477	.0$_3$5265	.0$_3$2388	.737311	.0$_3$3687	.101937	.0$_6$3724	.0$_6$2778	1.00000	.0$_7$6518	.0$_6$9766
Lbs. C.	14544.0	8080.00	3665.03	113150$_2$	5657.63	1564396	5.71434	4.26285	153470$_2$	1.00000	14.9876
Lbs. H_2O	970.400	539.111	244.537	754971	377.487	104379	.381270	.284424	1023966	.066744	1.00000

"P. C. U." refers to the "pound-centigrade unit." The ton used is 2000 pounds. "Lbs. C" refers to pounds of carbon oxidized, 100% efficiency equivalent to the corresponding number of heat units. "Lbs H_2O" refers to pounds of water evaporated at 100°C. = 212°F. at 100% efficiency

By the use of the foregoing table[1] about 330 interconversions among twenty-six of the standard engineering units of measure can be directly estimated from the alignment chart to three significant figures or calculated by simple multiplication to six figures. The multiplier factor given in the table is located on the center scale "A" giving the point which when aligned with any number point on "C1" determines the product on "C." Imperfections in the scale due to lack of precision in printing should be checked at intervals along "A" scale by actual division of "C" by "C1," the lines being left out so that the reader can do this. A line scratched on a transparent celluloid triangle gives the best medium for making alignments.

When volume and weight interconversions are given, water is the medium the calculations are based upon. By the introduction of specific gravity factors the medium can be changed, giving the weight of any volume of any material, etc.

[1]Compiled by and published by the courtesy of the engineering staff of the du Pont company.

Extraction of Juice From the Sugar Beet

Brief Outline of Modern Practice in the Beet-Sugar Refinery—Fluming and Washing—Design of Equipment—Diffusion Cell and Battery—Effect of Temperature on Purity

By WALLACE MONTGOMERY

THE advances made in chemical engineering during the past few years have not been adopted as readily by sugar manufacturers as by other industrial concerns. They have recently awakened to the fact, which is made evident by their increased rate of production as compared with earlier years. The harvesting season being short, the factories are forced to lie idle for many months of the year. This fostered the tendency on the part of the owners to be conservative regarding changes unless thoroughly proved of value.

The manner of harvesting and transporting beets has changed considerably, but there is still unlimited opportunity for improvements. The manufacturing operations proper have to deal with the beet after it has been delivered into the storage bins, and the resulting products from the working up of the beet.

The beets are flumed into the factory by water from the tail pipes of condensers, the amount of which water should not be less than 950 to 1,000 per cent on beets handled. A larger quantity insures an adequate supply of beets at all times. The fluming of the beets is beneficial in that much of the adhering particles of the dirt is removed, also trash and tops are separated. There is some water absorption during the time the beets enter the water until they are taken up in elevator to scales. This has been found to vary with the temperature of the water and the class of beet, though 0.2 per cent is an approximate figure. The beets pass over separators to remove rocks or any foreign substance.

Beet Water

A drawing of one type of equipment for removing the beets from the flume and placing them in the washer is shown in Fig. 1. The wheel revolves and picks up the beets, allowing them to drop into the washer, from which they are worked toward the farther end by paddles, a continual stream of water flowing through the washer at all times. From the washer the beets pass over a picking table or series of rolls as in this particular case, these rolls being set just far enough apart to keep the beets moving but allowing any small pieces or tailings to drop through to a separator directly below.

For a number of years the tailings and broken pieces of the beets removed from the picker were either thrown away or used as feed for hogs. At present it is the usual practice to work them up along with the whole beets. The quantity of tailings will vary greatly, as also will the sugar content. A specific case in which the author conducted a test over practically an entire campaign gave the following results:

	Per Cent
Tailings on beets worked..............	0.2
Sugar in tailings......................	7.40
Apparent purity.......................	80.00

Scrolls are also used in elevating beets from flume to pickers or washer, and one large American factory uses an air lift successfully.

From the rolls or picking table the beets are discharged into an elevator and are then carried up to the top floor of the factory, where they are discharged into a hopper and through some form of scales where the weight for the factory control is obtained. The checking of the scales is very important, as a slight error here throws off the entire results throughout the house.

From the scales the beets drop into a hopper and feed into the cutters, where they are sliced into V-shaped slices called cossettes. The cossettes enter the diffusion cells, where the first important step in sugar manufacture takes place—the extraction of the sugar in the cossettes by diffusion—and the handling of the diffusion juice calls for continuous control and care to prevent unnecessary losses and to keep the unavoidable losses within reasonable limits.

Fig. 2 shows the construction of a diffusion cell.

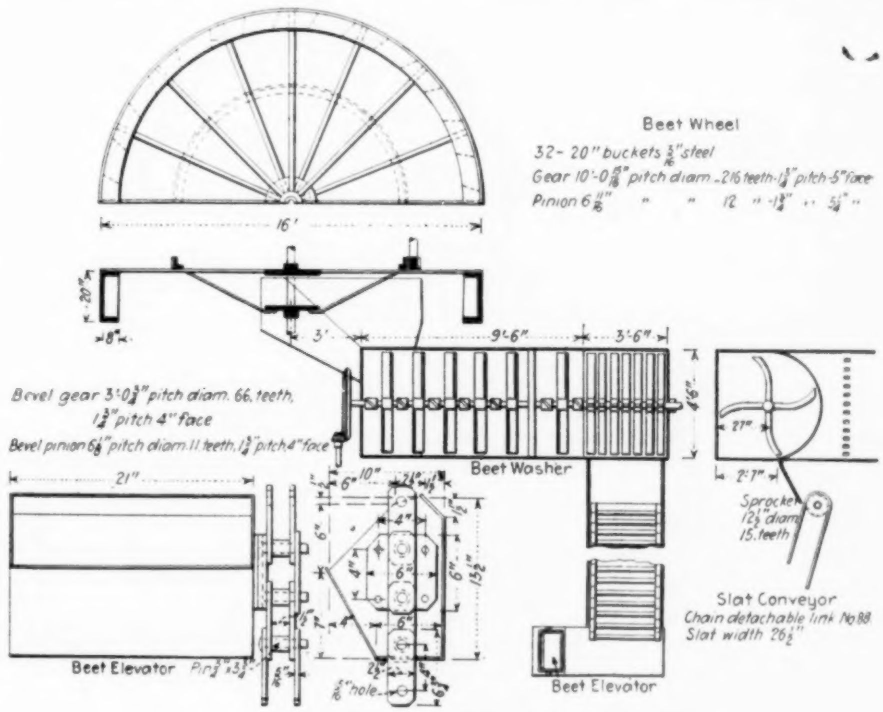


FIG. 1. BEET WHEEL WASHER AND ELEVATOR

These cells are arranged either circularly or in a straight line, known as circular battery and straight battery. Both have advantages, though in economy of space and ease of manipulation a circular battery is to be preferred.

There are a number of processes and methods of diffusion. That of Naudet has recently attracted most attention. Fig. 3 shows a Naudet battery in plan.

The losses taking place at the batteries may be calculated from the following data obtained from the laboratory where analyses are being made continuously upon all products.

	Per Cent
Sucrose in beets	18.50
Purity (apparent)	84.00

	Per Cent on Beets
Battery Losses:	
Sugar in pulp	0.16
Sugar in pulp water	0.05
Total known loss	0.21

Total sugar entering house = 18.50 − 0.21 = 18.29 per cent

Giving a battery extraction of 98.86 per cent of suger in beets and a loss of 1.14 per cent of sugar in beets.

Assuming the analysis of the diffusion juice to be:

Brix, deg.	14.00
Per cent sucrose	11.69
Apparent purity, per cent	83.50
Ash, per cent	0.62

Then the total solids entering house would be

$$18.29 \times \frac{100}{83.50} = 21.91 \text{ per cent on beets}$$

Non-sugars entering house are:

21.91 − 18.29 = 3.62 per cent on beets

Organic non-sugars are:

3.62 − 0.62 = 3.00 per cent on beets

The Percentage Draft

The percentage draft or amount of juice drawn from the diffusion battery varies from 125 to 160 per cent on

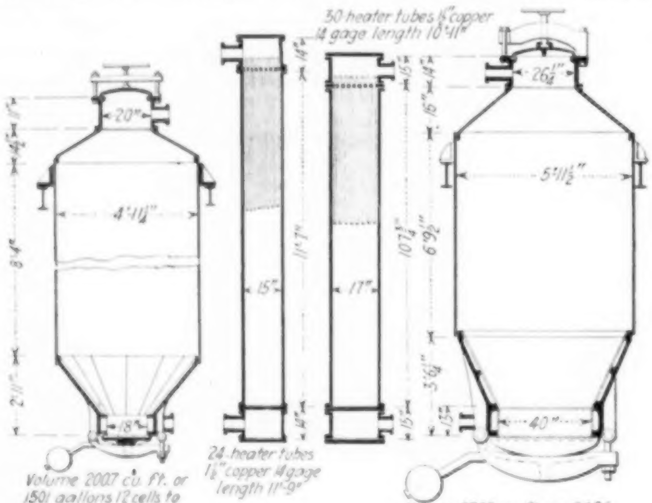


FIG. 2. DIFFUSION CELLS

beets and in some cases may be even higher. From our previous calculation the draft would be

$$\frac{18.29}{11.69} \times 100 = 156.5 \text{ per cent}$$

The percentage draft is held at a point where the losses are the lowest and the juice still of sufficient density to not require excessive evaporation.

The amount of steam necessary for diffusion varies considerably, due to the temperature of battery water, temperature of beets and temperature of juice drawn. Usually 2.5 to 5.5 per cent on beets worked will suffice.

To calculate the time of diffusion or the average time one cell remains in circulation we must know the total number of cells made each twelve hours and the number of cells over which circulation is carried, assuming that on a 14-cell battery 100 cells were made in twelve hours and the circulation carried over twelve cells.

Then time of diffusion $= \frac{14}{100} \times 12 = 1.68$, or 1 hour 41 min.

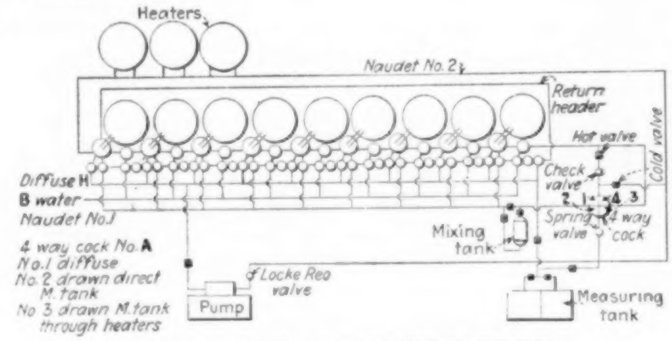


FIG. 3. PLAN OF NAUDET BATTERY

By per cent fill in battery is understood the pounds of beets per each 100-lb. capacity of the cell space of water.

Assuming cell capacity to be 200 cu.ft., or 56.6 hectoliters,

Number of cells worked	170
Tons beets worked	600

Cell capacity, 200 cu.ft. × 62.3 = 12,460 lb. water

$$\text{Tons beets per cell} = \frac{600}{170} = 7{,}040 \text{ lb.}$$

$$\text{Percentage fill} = \frac{7{,}040}{12{,}460} = 56.5 \text{ per cent}$$

Temperature and Purity of Product

The varying purity and sugar per cent in the different cells is shown by Fig. 4. This varies, of course, but under ordinary conditions the curve is approximately the same. The figures above the curve denote the temperature of each cell, and those below indicate the percentage of sucrose in each cell at the time samples were taken.

The regulation of temperature is of the utmost importance and in no case should it exceed 97 deg. C. The beets will to a certain extent determine what temperatures may be carried, because with a well-matured beet high temperature causes the pulp to become mushy and very hard to dump from the cells. With firm beets not quite ripe higher temperatures may be carried,

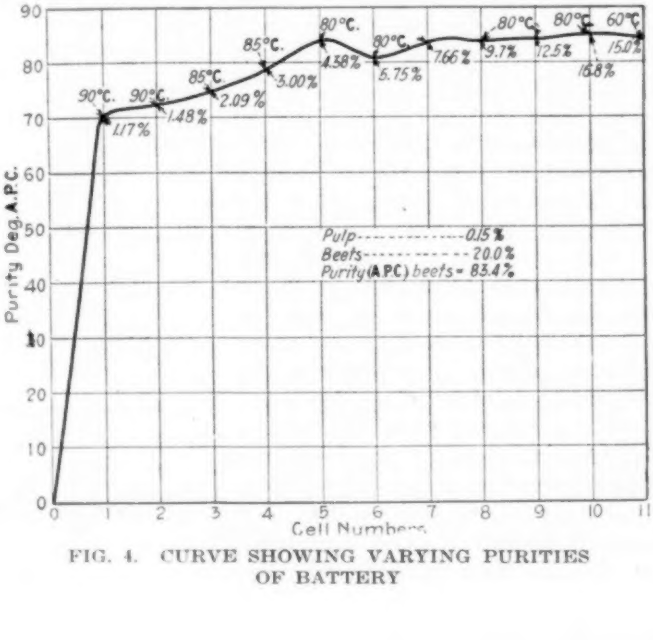


FIG. 4. CURVE SHOWING VARYING PURITIES OF BATTERY

though the amount of gums freed from the pulp is very detrimental to the further working up of juice and so offsets any gain in extraction.

The pulp of diffused cossettes is 80 per cent by weight on beets worked, while waste, the water remaining in the cell at time of discharging, amounts to 150 per cent on the weight of the beets. The discharging of the exhausted cossettes in nearly all modern factories is done by mechanical means, the bottom door being operated by hydraulic pressure governed by an operator above. Fig. 2 shows an old type door operated by hand, which in closing and locking properly takes too much time. One of the most ingenious improvements relating to the battery is the water inflated gasket for bottom of cell doors. This consists of a heavy circular rubber tube on the same order as an inner tube for automobile tires. When the door is to be opened the pressure is released from the gasket. After closing the door again, the gasket is inflated, thereby making a tight joint and preventing leakage from the cell bottom, the door and bottom of cell being grooved to receive this gasket. No attention is required, only examination occasionally. The pulp and waste water are removed from battery pit by centrifugal pumps and sent to a silo, where the water drains off and the pulp remains to be used as cattle feed, or else it is sent directly to the drying department, where it passes through a press or series of presses. It is then dried in large rotary driers heated by steam or hot gases obtained from furnaces in which oil is burned.

The pulp, as it enters the drier is of the following composition:

	Per Cent
Moisture	93.0 — 95.0
Sucrose	0.32 — 0.45

After passing through the presses the moisture is about 83 to 85 per cent, and from the driers ready for sacking contains only 11.5 to 12.5 per cent moisture, and about 32 to 35 per cent will pass through a 10-mesh sieve. The pulp contains about 0.50 to 0.55 per cent sugar.

Union Sugar Co.,
Betteravia, Cal.

Heat of Dissociation of Iron Pyrites

BY HEIHACHI KAMURA

THE object of this investigation was to find the heat absorbed in the decomposition of iron pyrites, FeS_2, into FeS and sulphur vapor. Previous attempts to measure this calorimetrically had not succeeded, and up to the present the heat of formation of pyrites from FeS and sulphur vapor is unknown.

Following the suggestion of Dr. J. W. Richards, the author measured the decomposition pressures at which sulphur vapor is given off by iron pyrites at different temperatures, with the object of finding the decomposition pressure curve, and thence deducing thermodynamically the heat absorbed in the decomposition.

Temperatures were measured by a platinum-iridium thermocouple. Pressures were measured directly upon a mercury pressure gage.

The experimental results are contained in the accompanying diagrams. Fig. 1 is the plot of the pressure in millimeters of mercury against the temperature in degrees C.[1]

Fig. 2 is a plot of the results showing logarithm of the pressure against the reciprocal of the absolute temperature. It will be seen that they conform reasonably well to a straight line relation between these quantities.

Fig. 3 shows the plot of the same observations extended to zero value of $\frac{1}{T}$, in order to illustrate the relation in its entirety, corresponding to

$$\log p = -\frac{8145}{T} + 11.50$$

which is the formula deducible from my experimental data.

The constant 11.50 in the above equation corresponds fairly well with that obtained for other similar decomposition pressure equations, there being a tendency for this value to lie between 9 and 12 for all decomposition pressures. The thermodynamic discussion of this formula makes Q, the heat of decomposition per molecular volume of sulphur vapor formed, $4.57 \times 8{,}145 = 37{,}223$, corresponding to the heat value of the equation

$$2FeS_2 = 2FeS + S_2$$

[1]The results of similar experiments recorded by Messrs. Allen and Lombard in the *American Journal of Science*, 1917, vol. 43, p. 175, are shown for comparison.

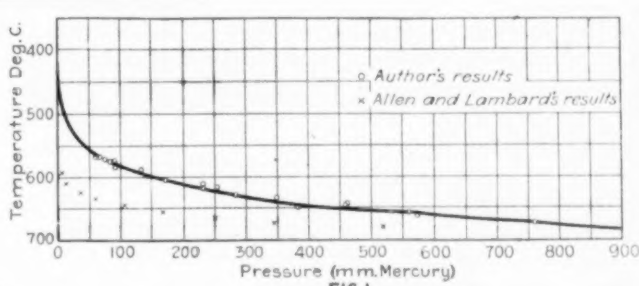


FIG. 1

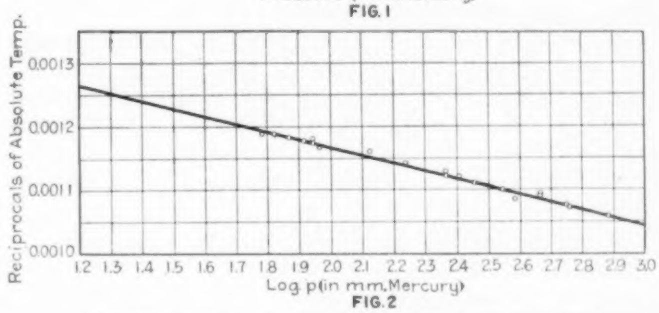


FIG. 2

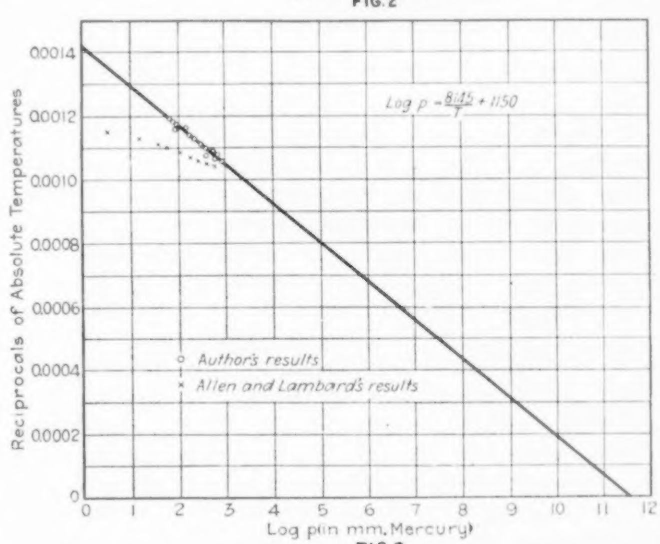


FIG. 3

We can, therefore, write the value of the heat absorbed per atom of sulphur or, rather, conversely, the heat evolved in the combination expressed thermochemically as follows:

$$(FeS, S_{gas}) = 18{,}611$$

Metallurgical Department,
Lehigh University.

Who Is Entitled to Inventions?

BY CHESLA C. SHERLOCK

INVENTIONS and the right to ownership in them have caused a good deal of litigation in our courts. The question of ownership in an invention must be determined before the right to the patent can be thoroughly established. And it is because of the value of the patent monopoly that the question of ownership is so bitterly contested before the courts.

The patent laws contemplated that the actual inventor of the new appliance should be the sole person entitled to the letters patent, and the law is so worded. It was not contemplated that the ownership could be vested in anyone but the actual inventor, especially in the earlier days of our patent history. But of later years it became apparent that persons other than the actual inventor might have a legitimate interest in the ownership of the fruits of his skill or inventive genius.

RIGHTS OF INVENTOR WHEN HE IS HIRED TO WORK ON INVENTION

The most common case is where an employer hires one of an inventive turn of mind on a stipulated salary to work on some appliance or invention for the benefit of the employer's trade or business. If the inventor fails to bring forth the desired invention, then the employer is the loser in the salary paid to the employee during his period of experimentation.

But suppose that the employed inventor does, in fact, succeed in bringing forth the invention which the employer has asked for? Suppose that the employer has paid him the stipulated salary, but that when the invention is a success the inventor claims that the invention belongs to him solely and he refuses to assign the patent rights or the ownership in it to the employer? What are the rights of the respective parties?

This is a question which has been so thoroughly threshed out by the courts that the principles are generally accepted as being settled. It will not be necessary for us to cite cases, unless someone comes forward and wants them to substantiate the principles here announced as to the rights of the respective parties.

COURTS SEEK TO PROTECT ACTUAL INVENTOR

The courts will make every effort to preserve the rights in the invention in the actual inventor. This does not mean that they will seek to ignore existing agreements or contracts or fail to take into consideration all the facts and circumstances surrounding each case.

The point is that the actual inventor is the one to be protected in all cases consistent with justice. He is the one for whom the whole theory of patent rights and privileges was first promulgated; he is the one to be favored and secured in any rights in danger.

But where an employer has expressly contracted with an inventor prior to the invention of a given appliance, method or machine, upon the express understanding that any rights which the inventor may have in the invention are to become the sole property of such employer in consideration of the stipulated salary, then the courts will take cognizance of this agreement and the right of ownership in the invention rests in the employer. This is practically the only case in which the employer of an inventor can step in and acquire any rights in the invention. And it is well to mark this fact.

Take a case where an employee, not expressly employed to perfect an invention, does bring forth an invention having commercial value. Does the employer have a right to share in the ownership on the theory that the employee learned things of advantage or used the knowledge and skill obtained on the employer's time in perfecting his invention?

EMPLOYER HAS NO RIGHT IN EMPLOYEE'S INVENTION EXCEPT BY SPECIAL PRIOR CONTRACT

It is the general rule that the employer has no right in the inventions of an employee unless they have expressly contracted concerning said invention. Employees are not deprived of their rights to an invention merely because they happen to be in the employ of another at the time they perfect their patentable ideas. To recognize any such rule would serve to defeat the very purpose for which the patent privileges were originally granted under the Constitution.

Inventions arising casually out of an employee's association with an employer, then, are not subject to any property rights vesting in the employer. The only instance where an employer can secure an interest in an invention perfected by an employee is for him to enter into a valid contract which grants him such right *prior* to the perfection of said invention, or an assignment of the rights in the patent subsequent to it.

CONTRACT MUST BE WRITTEN AND ENFORCEABLE, NOT A MERE UNDERSTANDING

It is well to pause right here and make it plain that this agreement must be in the form of a contract which can be enforced in the courts. A mere mutual understanding that the employer is to have all rights or a share in the ownership of an invention which the employee is to bring forth is not sufficient to confer that right upon the employer. The presumption in such a case would be against the employer and in favor of the actual inventor.

The contract must be a written agreement and, as such, enforceable at law. This means that it must be for a valid consideration, made by proper parties and for a lawful object. Failing in this, the employer will only be the loser and there is no redress for the wrongs he suffers.

If the employee has permitted his employer to use the invention, the law presumes that the employee or inventor has granted a license to such employer for the use of said invention. And this license or right to use will continue even after the employee-inventor has left the employment of the original employer.

Indigo in the Dutch East Indies

Indigo is grown on about forty estates in Java, as well as by the natives. The estate indigo contains from 60 to 80 per cent of indigotine. The native product averages only ¾ to 1 per cent of indigotine, and is for the greater part used in the island, principally for battiking, while the overproduction usually finds a market in Singapore. Before the war most of the dry indigo went direct to the Netherlands and the wet product to Singapore. In 1917 Japan entered the market for both the wet and dry product, and in the following two years took the bulk of the dry product. During 1920 Singapore was an important market for the product. The United States bought a small quantity of dry indigo in 1917, increasing its purchases in the following year, but has since been out of the market.

Cobalt Brasses*

Cobalt in Brass Acts Much Like Nickel in Brass, Despite Their Different Influence on Steel—Of All the Elements Investigated, Cobalt Is Unique in Possessing a Variable Coefficient of Equivalence

BY LEON GUILLET

THE following study was made with the view of comparing the rôle of cobalt with that of nickel in Cu: Zn alloys, as presented in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 261.

It is first necessary to give the binary diagrams of Cu: Ni, Cu: Co, Zn: Ni and Zn: Co. According to the most recent works the constitution of these different alloys are:

COPPER: NICKEL

This is a classical diagram and according to Guertler and Tammann[1] is as shown in Fig. 1. The liquidus is formed of a single branch of a curve without maximum or minimum and the solidus consists of a single branch located slightly below. Two lines representing the magnetic transformation can be noted below 320 deg. C., but no other change appears in the solid. Magnetic transformation point is rapidly lowered as the copper content is increased, varying from 330 deg. C. (626 deg. F.) to 0 deg. C. (32 deg. F.), the copper being respectively 0 and 48 per cent.

COPPER: COBALT

The copper: cobalt diagram (Fig. 2) is quite different,[2] approaching that for copper: iron. The liquidus indicates a transition point near pure copper. The upper branch of the liquidus is quite irregular and all alloys containing up to 80 per cent of copper melt above 1,300 deg. C. (2,375 deg. F.). The solidus is formed by a branch starting at the fusion point of cobalt (1,490 deg. C., or 2,714 deg. F.) and reaching the horizontal line corresponding to the transition point (1,110 deg. C., or 1,850 deg. F.) at a point where the copper content of the solid solution is 12 per cent. A short curved branch also starts on the transition horizontal at copper 97 per cent and ends at the melting point of pure copper.

Immediately below the solidus, in the neighborhood of pure cobalt is found a solid solution between β non-magnetic cobalt and copper (constituent I). In the neighborhood of pure copper, a zone of small extent locates a non-magnetic copper: cobalt solution (constituent II). A zone of far greater extent below the horizontal part of the solidus consists of a heterogeneous mixture of constituents I and II. But the non-magnetic solid solution becomes magnetic at higher temperatures. We therefore have various transformation lines as follows: Cobalt loses its magnetism at 1,159 deg. C. (2,118 deg. F.). This transformation point in constituent I is lowered to about 1,050 deg. C. (1,920 deg. F.). After this transformation the alloys contain a constituent III which is simply solid solution I, consisting of copper in cobalt, become magnetic. There is also a very small zone of constituents I + III. At the extreme right of the diagram, the non-magnetic solid solution II becomes magnetic at temperatures which are approximately determined as shown by region IV.

The horizontal line at 1,050 deg. C. (1,920 deg. F.) separates mixtures of solutions I and II from mixtures of zones III + II, and the horizontal line at 955 deg. C. (1,751 deg. F.) separates the latter from a zone consisting of a mixture of solutions III + IV. It is to be noted that in the last region both solid solutions are magnetic, in the next above only the cobalt-rich solution is magnetic, and in the zone just below the solidus neither constituent is magnetic.

ZINC: NICKEL

Equilibrium in the zinc: nickel system has been studied by Tagel[3] despite difficulties caused by volatilization of the zinc. Researches were made first on alloys containing up to 24 per cent nickel, but the diagram shown in Fig. 3 has subsequently been completed. The liquidus, starting from the melting point of nickel, is

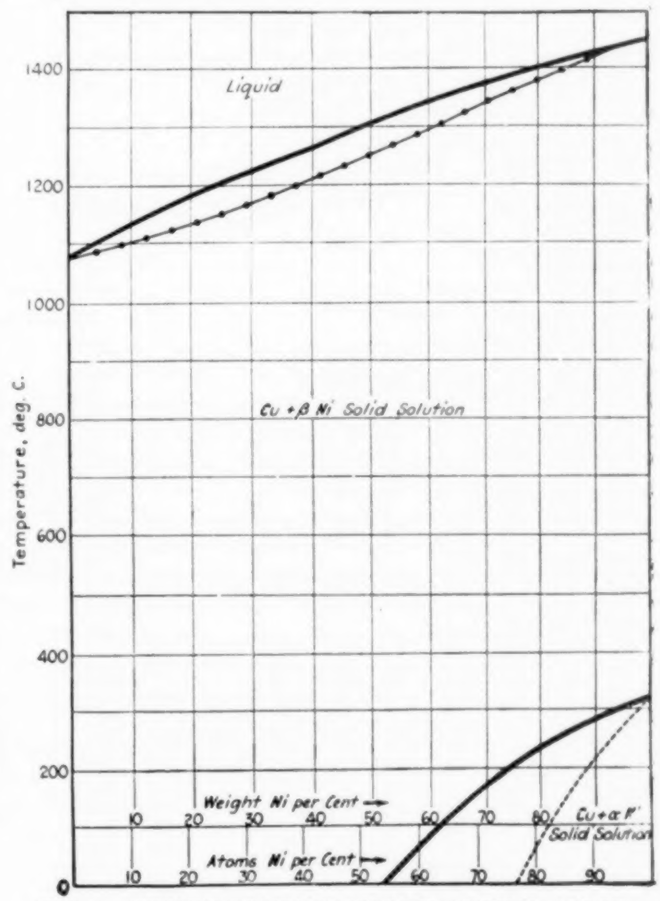


FIG. 1. BINARY DIAGRAM COPPER: NICKEL ALLOY

*From *Revue de Métallurgie*, vol. 17, No. 7, p. 494 (1920).

[1] *Z. anorg. allgem. Chem.*, vol. 52, p. 25 (1907).

[2] Salmen, *Z. anorg. allgem. Chem.*, vol. 57, p. 1 (1908).

[3] *Z. anorg. allgem. Chem.*, vol. 57, p. 34; *Revue de Métallurgie*, vol. 4, p. 781; vol. 5, p. 413.

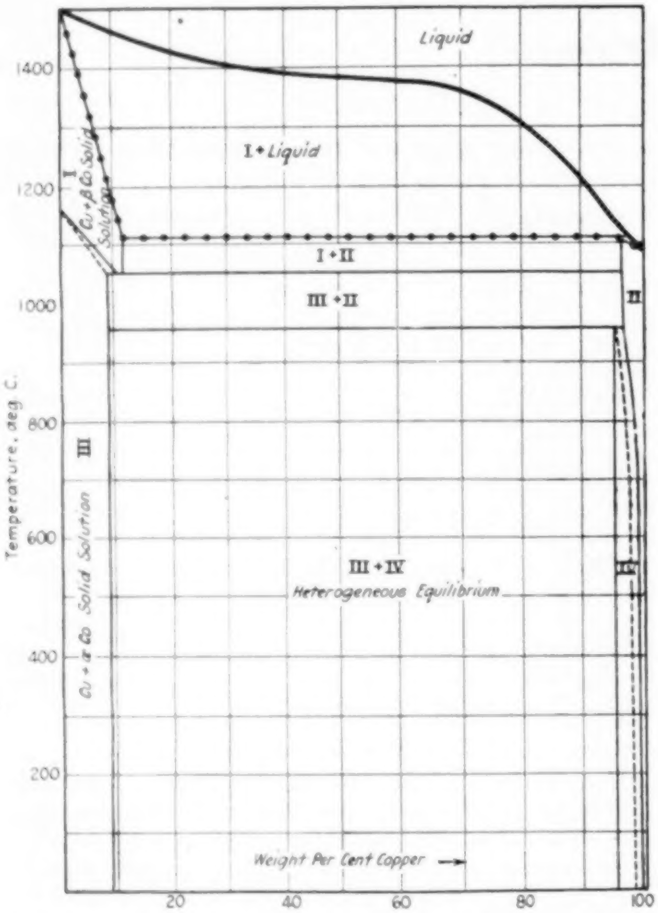


FIG. 2. BINARY DIAGRAM COPPER: COBALT ALLOY

lowered rapidly and shows a transition point at about 54 per cent zinc and 1,035 deg. C. (1,895 deg. F.), a eutectic at 870 deg. C. (1,598 deg. F.) and 73 per cent zinc and the maximum corresponding to the compound $NiZn_3$ fusing at 876 deg. C. (1,609 deg. F.). Beyond this maximum the liquidus drops rapidly to the melting point of zinc (419 deg. C., or 786 deg. F.).

The solidus is formed of a line starting from the melting point of pure nickel and ends in the transition horizontal at 35 per cent zinc. A new oblique line starts at approximately the transition point on the liquidus. This branch reaches the eutectic horizontal at 61 per cent zinc and this horizontal extends a little distance beyond the eutectic point. The solidus is then formed of two curved branches reaching the maximum on the liquidus at the compound $NiZn_3$, the right hand being extremely steep, reaching horizontal at the melting point of zinc, following this horizontal to the end of the diagram.

The conformation of liquidus and solidus indicates the existence of: Region I, a solid solution of zinc in β nickel. Region V, a solid solution below the transition horizontal, and which may be due to a suppositious compound, NiZn. Region VII, the solid solution of $NiZn_3$. A first eutectic between constituents V and VII. A second eutectic between pure β zinc and the solution containing compound $NiZn_3$. (Zone VII + β Zn.)

Study of the diagram also shows other transformation points, some of which are very interesting.

At the nickel side the magnetic transformation in the solid solution is depressed until for 20 per cent nickel it does not occur above ordinary temperature. Constituent II is therefore a solid solution of zinc in magnetic nickel. At the zinc side the transformation takes place at a constant temperature (360 deg. C., or 680 deg. F.) because the zinc retains its identity in alloys containing as high as 10 per cent nickel. The solid solution V forms a eutectoid with 59 per cent zinc at 655 deg. C. (1,211 deg. F.) between solid solution VII and constituent VI (compound NiZn). This is a good example of a chemical compound formed during the decomposition of a solid solution.

Zinc: Cobalt

Zinc: cobalt has been studied by Lew Konja[4] as far as alloys containing 40 per cent cobalt. This portion of the diagram (Fig. 4) is very similar to the similar end of the zinc: nickel diagram (Fig. 3).

The liquidus starts from pure zinc and rises rapidly. Higher than 20 per cent cobalt the diagram could not be traced with precision. The solidus consists of a horizontal line at 414 deg. C. (777 deg. F.) starting from 87 per cent Zn and reaching over nearly to pure zinc. It would seem that the eutectic does not correspond to exactly pure zinc, but is an alloy containing about 0.5 per cent cobalt.

Constituent I is the pure β zinc; the eutectic would be formed of β zinc and a constituent III, a poorly defined zinc: cobalt solid solution. Zone III + β Zn separated by the horizontal line at 360 deg. C. from zone III + α Zn do not differ except by the allotropic state of the zinc.

To summarize:

Copper: nickel alloys are formed of a single solid solution, which is non-magnetic or magnetic depending upon the content of nickel.

Copper: cobalt alloys are composed of two conjugate

[4] Z. anorg. allgem. Chem., vol. 59, p. 293 (1908).

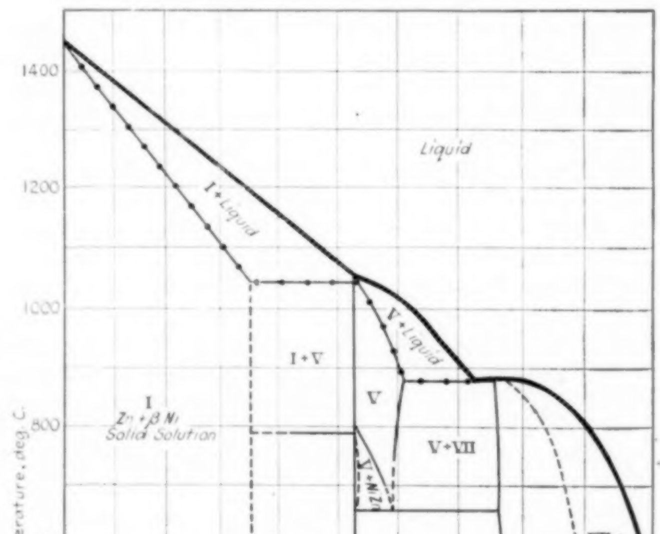


FIG. 3. BINARY DIAGRAM ZINC: NICKEL ALLOY

solid solutions varying somewhat in composition, both of which exist in the magnetic and non-magnetic forms at the proper temperatures.

Zinc: nickel alloys exist in solid solutions extending from pure nickel to 50 per cent zinc. Nickel appears to be insoluble in zinc, however. There are also two compounds, NiZn and $NiZn_3$, the last one appearing in solid solution in nearly all the zinc-rich alloys.

Zinc: cobalt alloys. The constitution is known only in the neighborhood of pure zinc; they are formed of pure zinc and of an imperfectly understood solid solution, as summarized in Fig. 4.

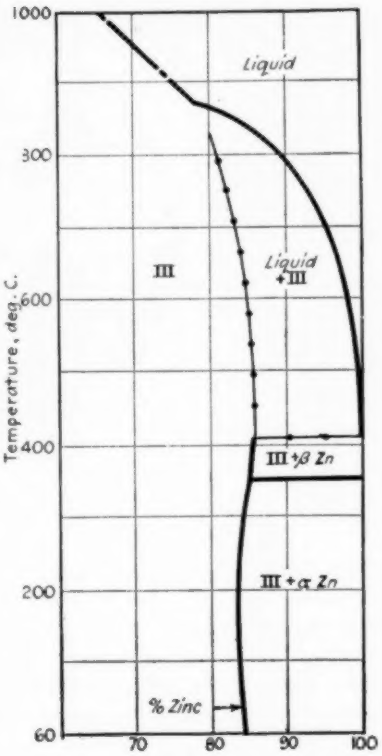


FIG. 4. BINARY DIAGRAM ZINC: COBALT ALLOY

Alloys Tested

In the study of cobalt brasses, the tests have been made under the same conditions as for nickel brasses.[5]

Table I shows the composition of the alloys tested. Three series were studied containing respectively about 70, 60 and 55 per cent copper, the cobalt increasing in each series from 0.5 to 5 per cent. In reality the figure given for cobalt represents the sum of nickel plus cobalt, since the composition of the cobalt used in making up the alloys was 93.13 Co, 0.78 Ni, 0.90 Si, 0.17 Cu, 1.61 Fe.

TABLE I. COMPOSITION OF COBALT BRASSES INVESTIGATED

		Analysis Wished			Analysis Obtained						Shock Tests	Hard-
No.		Cu	Co	Zn	Cu	Co	Zn	Fe	Pb	Total	Angle	ness
Series A	1	70	1	29	70.20	0.72	28.96	0.07	tr.	99.99	...	44
	2	70	2	28	70.28	1.94	27.66	0.07	tr.	99.95	...	76
	3	70	5	25	70.76	4.35	24.79	0.07	tr.	99.97	...	82
Series B	4	60	1	39	60.34	0.64	38.86	0.07	tr.	99.91	106	72
	5	60	2	38	60.50	2.27	37.06	0.07	tr.	99.99	116	71
	6	60	5	35	60.48	4.81	34.62	0.08	tr.	99.99	150	107
Series C	7	55	1	44	55.46	0.78	43.66	0.08	tr.	99.98	138	117
	8	55	2	43	55.63	2.42	41.86	0.07	tr.	99.98	134	104
	9	55	3	40	55.46	4.98	39.45	0.08	tr.	99.97	140	125

Micrographic and Macrographic Examination

Series A.—The alloy 70.2 Cu, 0.72 Co is formed by a single solid solution in relatively coarse crystals. It can be admitted *a priori* that it is the α solution of brasses. Alloy 70.28 Cu, 1.94 Co is also formed of a single solid solution; but with the same rate of cooling, the crystals are of much smaller dimensions than the former. Alloy 70.76 Cu, 4.35 Co (Fig. 6) contains two constituents, a solid solution whose elements are much smaller than either of the preceding, and a star-like special constituent which looks very much like one of the solid solutions in the binary copper: cobalt system.

[5]CHEM. & MET. ENG., vol. 24, p. 261.

Fig. 5 shows the macrographs of the above three alloys at full size after etching with boiling 20 per cent ammonia persulphate solution. It is evident that the presence of cobalt has a considerable influence on the grain size.

Series B.—Brass with 60.34 Cu, 0.64 Co is formed α + β constituents. Its fictitious composition (61 per cent) as shown in the microscope is a little higher than the real. Alloy 60.50 Cu, 2.27 Co possesses a structure analogous to the above, but its fictitious composition is even higher, being around 62 per cent. Brass containing 60.48 Cu, 4.81 Co shows but little β, but has a little of a special constituent apparently the same as found in the brass 70.76 Cu, 4.35 Co of Series A (Fig. 6).

Calculating the coefficient of equivalence[6] for cobalt from these data, disregarding the last sample, which contains a constituent other than the normal solid solutions found in brasses, it is found that the value of t varies between —0.7 and —0.1.

Macrographs of this series again show that cobalt has a very great influence on the grain size.

Micrographs Figs. 7 and 8 (magnified 74 diameters) show the structure of these alloys.

Series C.—The three alloys with about 55 per cent copper are formed of α and β solutions, none presenting any special constituent, as may be seen in Figs. 9, 10 and 11. But it is apparent that they all present very different fictitious compositions, determination of which will serve for calculating the coefficient of equivalence t for cobalt.

Alloy 55.46 Cu, 0.78 Co has a fictitious composition of

[6]See CHEM. & MET. ENG., vol. 24, p. 177.

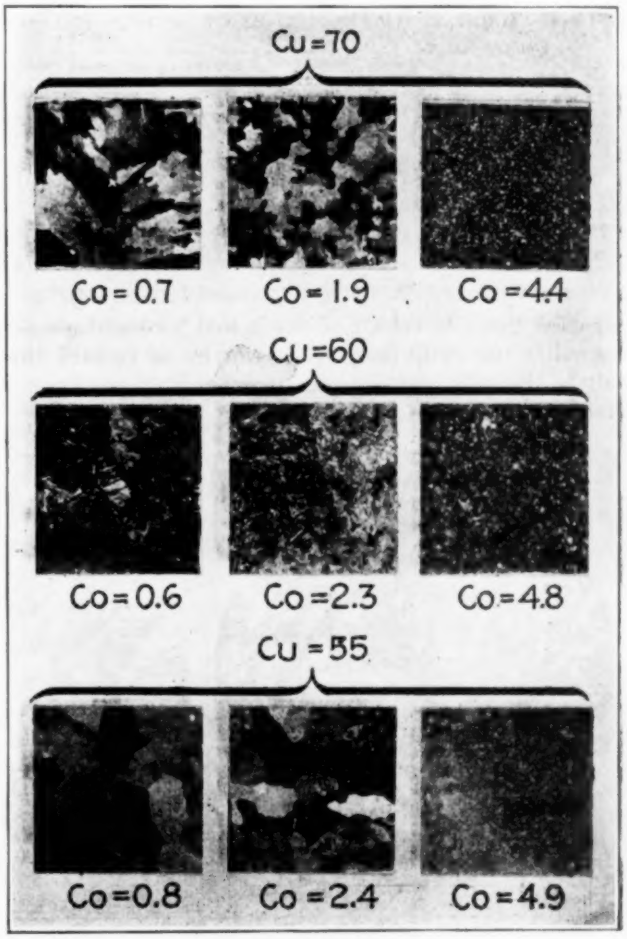


FIG. 5. MACROGRAPHS OF COBALT BRASSES

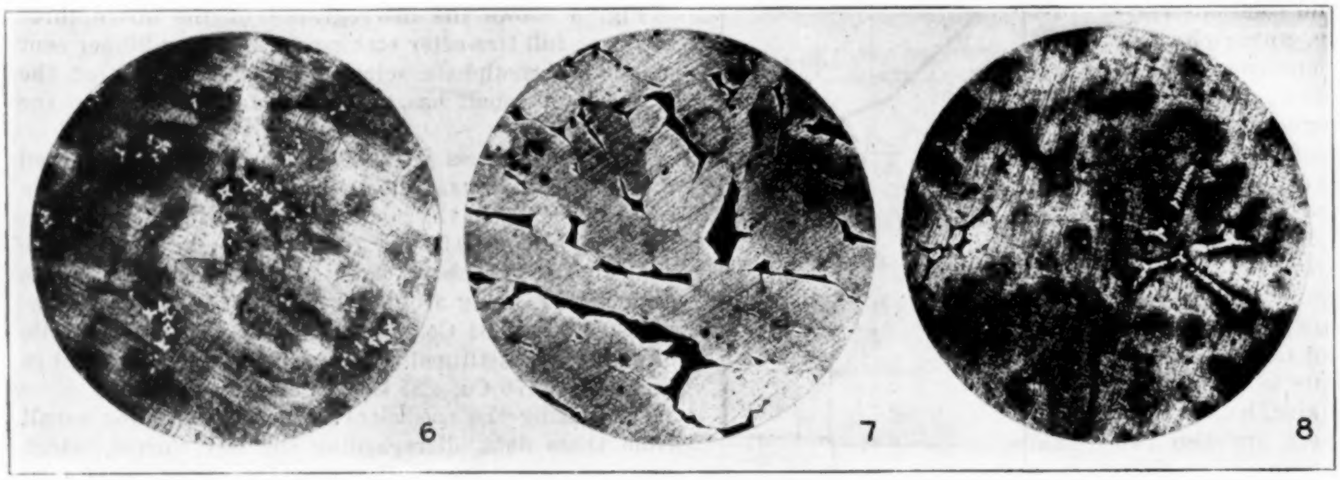


FIG. 6 TO 8 (ALL × 55)
Fig. 6. 70.76 Cu, 4.35 Co brass. Fig. 7. 60.5 Cu, 2.27 Co brass Fig. 8. 60.5 Cu, 4.81 Co brass.

56.5 Cu, that of the alloy 55.63 Cu, 2.42 Co is 59 Cu, and that of the alloy 55.46 Cu, 4.98 Co is approximately 61 Cu. The coefficient of equivalence calculated from these values is respectively

$$t = -1.5, t = -1.4, t = -0.9.$$

Macrographs again show clearly that the grains become smaller as cobalt increases.

It is to be noted that there is an important variation in the coefficient of equivalence of cobalt for variations in the composition of the alloy under examination, the values of t varying between —0.1 and —1.5. It would seem that the nearer the alloy approaches the point where the special constituent appears—i.e., to the saturation limit in cobalt of the α and β constituents—the smaller the coefficient. It is worthy of remark that cobalt is the only element yet known which possesses a variable coefficient of equivalence.

TABLE II. MECHANICAL PROPERTIES OF COBALT BRASSES

	Composition		Tension Tests			
No.	Cu	Co	Ultimate Strength	Elongation	Contraction in Area	ρ
1	70.20	0.72	31,000	57.0	....	17.1
2	70.28	1.94	32,100	22.0	42.2	12.5
3	70.76	4.35	47,900	51.0	62.2	15.3
4	60.34	0.64	46,600	49.0	57.5	13.1
5	60.50	2.27	44,300	57.0	54.6	11.5
6	60.48	4.81	47,400	38.0	37.7	7.5
7	55.46	0.78	53,600	16.0	30.7	9.0
8	55.63	2.42	57,700	32.0	38.9	11.2
9	55.46	4.98	63,400	39.0	54.6	14.0

The tests for the mechanical properties of cobalt brasses have been made under conditions similar to those used for the nickel brasses,[7] only cast samples being tested. The results obtained are tabulated in Table II.

The results are often irregular (notably alloy No. 2 under tension) but some interesting conclusions may be drawn.

Thus: Series C (alloys Nos. 7, 8 and 9) clearly show the relation between the fictitious composition and the mechanical properties. The strength and the elongation increase simultaneously.

TABLE III. TRANSFORMATION POINTS OF COBALT BRASSES

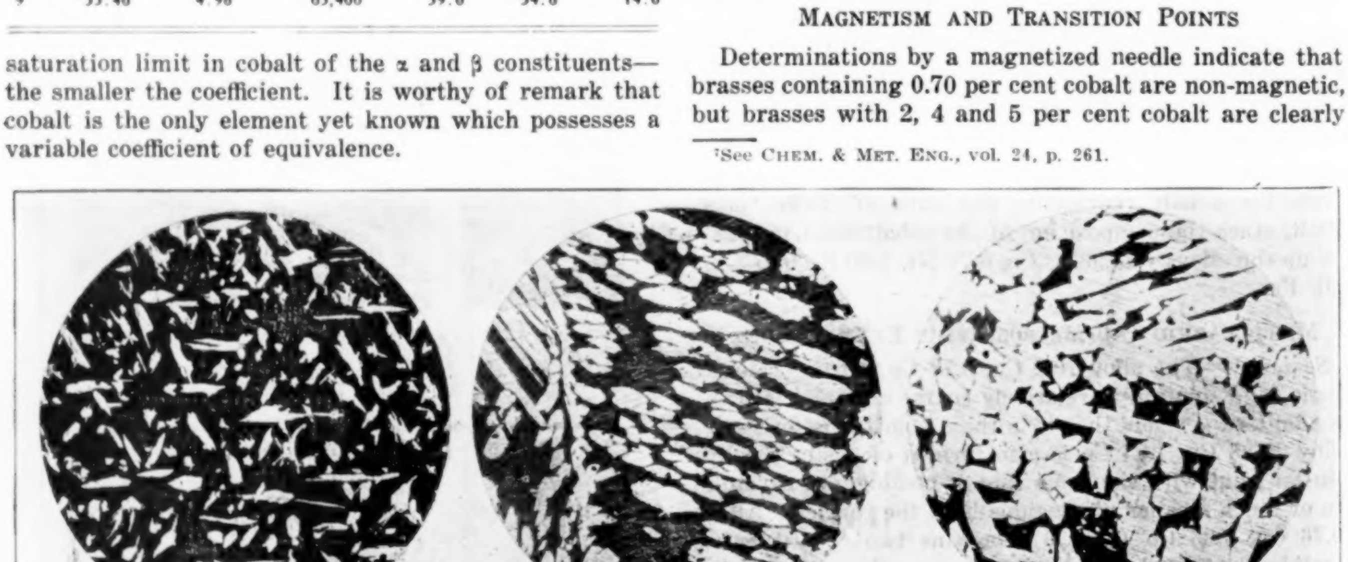
Alloys Tested			Transformation Points		Maximum
Cu	Co	Fictitious Composition	On Heating	On Cooling	Temperature Attained
70.76	4.35	d + special constituent	?	?	875
60.34	0.64	61	455—790	750—455	860
60.48	4.81	a + special constituent	?	?	850
55.46	0.78	56.5	460	455	845
55.46	4.98	61	470—815	790—400	860

Alloy No. 6 (high-cobalt) shows a very appreciable decrease in elongation, a fact which is not observed for alloy No. 3, although both these products contain a little of a special constituent.

Magnetism and Transition Points

Determinations by a magnetized needle indicate that brasses containing 0.70 per cent cobalt are non-magnetic, but brasses with 2, 4 and 5 per cent cobalt are clearly

[7]See Chem. & Met. Eng., vol. 24, p. 261.



FIGS. 9 TO 11 (ALL × 55)
Fig. 9. 55.4 Cu, 0.78 Co brass. Fig. 10. 55.6 Cu, 2.42 Co brass. Fig. 11. 55.46 Cu, 4.98 Co brass.

magnetic, the magnetism increasing with the increase in cobalt.

Transformation points have been determined with a Saladin-Le Chatelier apparatus and the results tabulated in Table III. The tests show that:

Cobalt brasses have transformation points which correspond approximately to those of ordinary brasses having real compositions equal to the fictitious compositions of the alloys considered.

Alloys having equal fictitious compositions have different transformation points, since the presence of cobalt slightly raises these temperatures. This is brought out by comparing the results on samples Nos. 2 and 5.

Microscopic observation failed to resolve the β constituent in any of the cobalt brasses studied.

Conclusions

Cobalt enters into solid solution in one or both of the normal constituents of the Cu: Zn alloys and creates a fictitious composition which is greater than the real composition.

The coefficient of equivalence of cobalt varies between wide limits, from —0.1 to —1.5, whereas that of nickel[5] is approximately —1.3.

A special constituent is isolated as the cobalt content increases, and the more readily for brasses of lower copper content. Only traces of this constituent were noted in the samples studied, so that it can be said that the alloy is not thereby altered extensively. It is to be noted, however, that the alloy 60 Cu, 4.8 Co has a considerably decreased elongation and resiliency.

Copper: cobalt solutions are much less extensive than those of copper: nickel.

Additions of cobalt are not of great industrial importance in the manufacture of brasses.

The rôle of cobalt approaches that of nickel in brasses, although these two metals have completely different effects in steels.

[5]See CHEM. & MET. ENG., vol. 24, p. 178.

The Manufacture of Nitric Acid

AT A MEETING of the Delaware Section, American Chemical Society, held Wednesday evening, Feb. 23, an address on "The Manufacture of Nitric Acid" was given by F. C. Zeisberg, manager of the elementary process section, E. I. du Pont de Nemours & Co.

Early Developments

In 778 A.D. Geber, an Arabian alchemist, obtained *aqua dissolutiva* from saltpeter, copper sulphate and alum. Because of its solvent properties, nitric acid was made on a semi-commercial scale even during the Middle Ages. Illustrations of the crude forms of apparatus will be found in a work by Lazarus Ercker published in 1580. The substitution of cast iron for earthenware retorts began between 1720 and 1759 and Chilean nitrate was first used as raw material in 1830. Until quite recently the horizontal cylindrical type of retort was extensively used in this country. The cast-iron cylinders were mounted in pairs in brick settings and the ends were closed with cast-iron plates or, in some cases, brickwork. A charge of 3,000 lb. of sodium nitrate was considered large.

In 1912 the du Pont company first installed the vertical or pot retorts.

Reactions Involved in Modern Process

Two equations are commonly used to express the formation of nitric acid from sodium nitrate and sulphuric acid:

$$2NaNO_3 + H_2SO_4 = Na_2SO_4 + 2HNO_3 \quad (1)$$
$$NaNO_3 + H_2SO_4 = NaHSO_4 + HNO_3 \quad (2)$$

It will be noticed that reaction 1 requires only one-half as much sulphuric acid as the second reaction. However, the saving in acid is offset by the fact that the residue left in the retort has such a high melting point as to make its removal a difficult and troublesome operation.

Experience has shown that an $H_2SO_4 : NaNO_3$ ratio of 1:1 by weight gives the best results. The cake formed in this case contains both Na_2SO_4 and $NaHSO_4$ and consequently has a melting point lower than that of either component. These relations may be summarized as follows:

	Ratio H_2SO_4:$NaNO_3$ By Weight	Molar	Melting Point of Residue, Deg. C.
Reaction 1	0.576	0.5	888
Reaction 2	1.15	1	186
Actual charging ratio	1	0.87	±178

For successful operation the 1:1 ratio should be adhered to rather closely. A higher ratio causes the phenomenon of "pumping" (which if serious may drive part of the charge into the condenser) and increases the sulphuric acid cost but gives a stronger distillate and lower repair costs. On the other hand, a low ratio saves sulphuric acid, but repair costs are higher and the distillate is weaker due to decomposition of nitric acid at the high temperature necessary in this case.

Raw Materials

Chilean nitrate as purchased has an average composition of 2.15 per cent H_2O, 1.70 per cent NaCl and 94.10 per cent $NaNO_3$. It is dried to below 0.5 per cent H_2O so as to avoid unnecessary dilution of the distillate. The size of the nitrate particles is important, since very fine material tends to form cakes in the retort. These may break up later and react with almost explosive violence, or they may remain unacted upon and thus lower the yield.

Sulphuric acid recovered from spent mixed acid used for nitrating is found to work well, no matter how black and muddy. Even tank bottoms containing 30 to 40 per cent ferric sulphate have been used successfully. The strength of the acid is important, however, since very strong acid will dehydrate the HNO_3 according to the reaction:

$$2HNO_3 \rightleftharpoons 2NO_2 + H_2O + \tfrac{1}{2}O_2 \quad (3)$$

The NO_2 passes through the condensers to the absorbers and later the water distills over, diluting the strong distillate. With dry $NaNO_3$, 92.5 per cent H_2SO_4 gives the optimum strength of distillate.

Distillation Phenomena

Curves plotted from the averaged data of ten runs with charges of 6,500 lb. $NaNO_3$ show many interesting phenomena. The strength of distillate is a little low at first due to water vapor and nitrosyl chloride, but soon rises to a maximum of about 97 per cent, after

which it falls off gradually. The rate of distillation increases to a prime of 18 lb. per minute about three hours after heat is applied and then decreases regularly. Soon after firing, the charge begins to foam and the foam depth increases until just before the end of the reaction, when the retort is practically full of foam. After reaching this point the foam drops abruptly and this serves as one of the best indications that the reaction is complete.

After the distillation has been in progress for about three hours the mushy charge sets to a solid pumice-like block which gradually melts again. This peculiarity has proved to be a most serious stumbling block for continuous processes which depend upon gravity flow.

The time required for a distillation cycle varies with the charge about as follows:

Charge Sodium Nitrate, Lb.	Single Shift, Hr.	Continuous, Hr.
4,000	7 to 8	...
5,000	9 to 10	...
6,000	10 to 12	...
7,000	12 to 14	12
9,000	Over 14	...

The Modern Plant

A modern nitric acid plant includes: A battery of retorts connected in pairs to condensers provided, as a rule, with bleachers; absorption towers for the recovery of uncondensed vapors; a variety of accessory apparatus such as charging devices for nitrate and acid, storage system for the weak and strong cuts or mixing tanks if mixed acid is to be made.

Retorts

Vertical cast-iron retorts are usually made with detachable hemispherical bottoms, although a recent bottom design is based upon the catenary of revolution, the theory being that this shape will give maximum strength. The retorts are set in brickwork and are heated directly by coal fires. The life of a retort is from 500 to 600 runs. Occasionally this is exceeded, as in the case of a retort at Repauno, which lasted 1,763 runs. During this time the thickness of the casting was reduced by erosion from 2 in. to about ¼ in. Most retorts fail through cracks developed by the heat. Patching prolongs the life about 100 runs.

Condensers

Several types of condensers are in use. The improved Hart condenser consists of one or more stands each containing fourteen inclined 3-in. glass tubes connected to baffled headers so that the vapors make three passes. Each stand offers about 50 sq.ft. of condensing surface. Tube breakage is high—about 100 tubes per retort per year.

The Hough Duriron condenser is very open in construction and offers little resistance to gas flow. When operating intermittently in cold weather, water is likely to become trapped in the condenser and burst it in freezing.

S-bend condensers of 6-in. Duriron or fused silica pipe cooled by trickling water over the outside are very efficient.

A condenser described by F. Moore and J. A. Hall in U. S. Patent 986,846 of March 14, 1911, and used at the Shand plant of the Canadian Explosives Co. on Vancouver Island gives a distillate containing less than 0.1 per cent NO_2. It consists of a tower containing a large number of vertical tubes inside of which the condensing water circulates. The condensed acid passes countercurrent to the hot vapors through a packed section at the base of the tower which serves as a bleacher.

Absorption System

No condensers were used in the earlier systems, the nitric acid being distilled directly into sulphuric acid. This gives a mixed acid containing nitroso sulphuric acid, which is undesirable for certain nitrations. The first absorption towers using water were built at Hercules, Cal., from sewer tile filled with broken beer bottles. The acid which drained from the bottom of each tower was allowed to flow into a carboy and when this was full, it was carried upstairs by workmen and dumped into the top of the next.

Modern towers are constructed of chemical stoneware, six sections 30 in. in diameter by 30 in. high forming a typical tower. Coke, lump quartz or specially designed stoneware packing may be used to fill the tower. If of the dimensions given, 3,600 3-in. rings would be required. Finding a suitable construction material for the saucer in which the tower rests presents quite a problem. Volvic stone saturated with some bituminous material is only fairly satisfactory. The same may be said of Duriron. The du Pont company has obtained excellent service from Maine granite.

The reaction which takes place in the towers is the reverse of reaction 3. In order to get a strong acid it is necessary to have a series of towers, with water entering at the end of the series and flowing countercurrent to the gases. The acid collecting in each saucer flows to a distributing pot provided with two discharge openings leading to two stoneware pulsometers which operate by compressed air and insure a rapid circulation of acid in the tower. The distributing pots are interconnected so that as acid is formed it flows from one tower to the next toward the strong acid end. Baffles in the pots prevent water from passing through the whole series into the strong acid when the air is shut off from the pulsometers.

Storage and Transportation

Very strong nitric acid can be stored in lead-lined tanks, although there is considerable corrosion in the vapor space above the acid. Weak acid is best kept in stoneware pots, these being available in sizes up to 530 gal. Around the plant the acid is handled in pipe lines of chemical ware, glass or Duriron.

At best, however, the problem of handling the pure acid is a troublesome one. Since nitric acid is now used almost exclusively as mixed acid and since this can be handled easily in steel tanks and tank cars, steel circulating tanks are usually provided in which the nitric acid may be mixed with the required amount of sulphuric acid.

As indicated above, transportation of nitric acid is difficult except in the mixed form containing at least 12 to 13 per cent of H_2SO_4. Glass carboys are used to quite an extent and for short distances chemical ware, glass or Duriron lines are satisfactory. In Germany and Norway, perfectly pure HNO_3 is transported in aluminum containers. Traces of H_2SO_4, Cl_2 or NO_2 cause rapid corrosion.

Yields and Costs

From 94 per cent in 1900, the yield rose to 96.8 per cent in 1913 and—in spite of wartime demand for out-

put—to 97.6 per cent in 1918. At present it is nearly 99 per cent. In 1913, the production of 1,000 lb. HNO_3 required 265 lb. of coal and 1.9 men-hr. labor. Corresponding figures for 1918 are 222 lb. and 1.4 men-hr.

The normal cost of producing 100 lb. of nitric acid is distributed as shown in the accompanying table.

NORMAL COST PER 100 LB. HNO_3

Labor	$0.06	
Repair labor	0.06	
Retorts	0.08	
Supplies	0.05	
Fuel	0.03	
Power	0.03	
Overhead	0.18	
	$0.49	
Less credit for nitercake	0.24	
Cost exclusive of raw materials		$0.25
Sodium nitrate, 145 lb @ 2.5c	$3.63	
Sulphuric acid, 151 lb. @ 1c	1.51	
Cost of raw materials		$5.14
Total cost		$5.39

It will be noted that the raw material cost far exceeds all other items and that, consequently, increasing the yield 1 per cent would have as much effect in decreasing the cost as doubling the life of the retorts. Although similar relations exist in many other chemical processes, they are often lost sight of and much time is wasted in misdirected efforts to diminish costs.

Production

Production statistics for the United States are as follows:

Year	HNO_3 Production, Short Tons
1904	59,000
1909	68,000
1914	79,000
1917	404,000
1918	634,000

Present production is somewhat above that of 1914. Normally the du Pont company makes one-third of the nitric acid produced in this country, but during the war the proportion rose to one-half.

Other Processes

The Valentiner vacuum process proved to be a failure commercially. Recently the Buffalo Foundry & Machine Co. has devised a vacuum process which promises to be very efficient. The retort is provided with a powerful agitator and the sulphuric acid is added automatically. In this way foaming is reduced to a minimum in spite of the fact that distillation takes place in a vacuum (maintained by a special pump having a sulphuric acid piston to minimize corrosion). No absorption towers are used, the uncondensed vapors being absorbed in concentrated sulphuric acid which is subsequently used in the retort. As noted above, the continuous process fails owing to the solidification of the charge at one stage.

Uses

Peace-time uses include: manufacture of chamber sulphuric acid, aqua regia, nitroglycerine, nitrobenzene, nitrocotton, fulminates and nitrates; pickling of copper, bronze and brass; parting of gold and silver; purification of silver; gilding bronze; photo-engraving; silk dyeing.

In war time it is used in making nitrocotton, nitroglycerine, trinitrotoluene, fulminates, ammonium nitrate and many other compounds.

Progress Report on Superpower Survey

THE Congress, in appropriating for the Geological Survey, June 5, 1920, provided for the survey of power production and distribution in the United States, including the study of methods for the further utilization of water power and the special investigation of the possible economy of fuel, labor and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries.

While the final report has not been completed, a progress report was submitted to the President on Feb. 24 by John Barton Payne, Secretary of the Interior, giving results thus far accomplished, with a brief statement of the scope of the investigation.

Engineering Staff and Advisory Board

An organization was effected under the Geological Survey with offices for the engineering staff in New York City. The engineering staff includes William S. Murray, as chairman; Nathan C. Grover, the chief hydraulic engineer of the United States Geological Survey; Ozni P. Hood, chief mechanical engineer of the Bureau of Mines; Lorin E. Imlay, division engineer for the subjects of power and transmission; Henry W. Butler, division engineer for industries, and Cary T. Hutchinson, division engineer for railroads, with Henry Flood, Jr., engineer-secretary. The engineering staff has been aided by the hearty co-operation of an advisory board of business and professional men, who accepted appointments for this special service. Of this board Prof. Lester P. Breckenridge of Yale is chairman, and the various interests connected with this investigation are represented as follows: Magnus W. Alexander of Boston, representing the National Industrial Conference Board; Edward G. Buckland, vice-president New York, New Haven & Hartford R.R.; Charles L. Edgar, of the Boston Edison Co., representing the National Electric Light Association; Abraham T. Hardin, vice-president New York Central R.R.; Herbert Hoover, representing the mining industry; William Kelley, Lieutenant-Colonel, U. S. A.; Elisha Lee, vice-president Pennsylvania R.R.; Dr. Arthur D. Little of Boston, representing the electrochemical and byproducts industries; James H. McGraw, president McGraw-Hill Co., Inc., representing the technical press; John H. Pardee of New York, representing the American Electric Railway Association; Henry Cleveland Perkins of Washington, representing the mining industry, and Matthew S. Sloan, of the Brooklyn Edison Co., representing the National Electric Light Association.

Having in mind the object of the Superpower Survey, viz.: (1) allocation and amount of waste in labor, coal and other materials, due to the improper form of power generation and distribution within the Boston-Washington zone, and (2) recommendations regarding a regional power system by means of which these wastes may be eliminated, the superpower report naturally divides itself into three divisions: (1) Physical, (2) Legal, and (3) Financial.

Physical Aspects of Survey

With regard to the physical aspect, the investigation has been concerned with the power necessary to (*a*)

railroads, (*b*) industries, (*c*) utilities, and (*d*) a system of centralized electric generation and transmission to supply their power requirements up to and including 1930.

Railroads

There are twenty class 1 railways included in the superpower zone. These are divided as follows: First track, 14,500 miles; second track, 6,500 miles; total trackage (including yards and sidings) 36,000 miles. There are a total of 10,000 steam locomotives, of which 44 per cent are freight, 29 per cent passenger and 27 per cent switching. The total annual railroad coal consumption for 1919 was 19,000,000 tons. Apparently one-third of this mileage can be economically electrified, including the greater part of double track mileage. Due to lack of traffic density upon the branch lines, these cannot be profitably electrified. This 33 per cent of mileage will carry more than 50 per cent of the traffic and by preferential arrangement of routes probably 60 per cent of the total traffic could be put over this mileage. Through the electrification of this mileage a fuel saving of 6,000,000 tons, or $40,000,000 per annum, would be effected. Added to this saving will be $50,000,000 annually as a difference in favor of electric versus steam engine repairs and maintenance.

The total unit cost of electrification will be approximately $40,000 per mile of main line track, which with 12,600 miles to be electrified would cost $500,000,000. In addition, yard and siding trackage would call for $300,000,000, or a total of $800,000,000. This sum will cover the necessary construction and equipment for the railways beginning with the electric substations and with the driving wheel of their electric motive power. The electrification outlined will displace approximately 7,000 steam locomotives, which at salvage value of $22,500 each will credit the electrification estimate with approximately $150,000,000, leaving a net investment of $650,000,000 which taken in connection with the aforementioned savings of $90,000,000 per annum would return approximately 14 per cent on the investment.

Industries

There are approximately 50,000 industrial plants in the zone which either purchase or generate power. The Bureau of the Census is at present compiling the statistics of the 1919 Census of Manufactures. It is heartily co-operating with the Superpower Survey and will prepare, on a form made up by this Survey, the power and fuel statistics for the superpower zone, which will show the power and fuel requirements in the thirty-six major industries in the following classification of plants: Plants which do not use any power, plants using only steam power, plants purchasing electric power, plants not in these classes. In addition the plants will be classified as to size.

As soon as the tabulations are completed by the Bureau of the Census, the Survey in conjunction with experts in the various industries, will analyze and ascertain what possible fuel savings could have been made by the superpower system in 1919. From the data at hand, a saving of between six and eight million tons of coal is indicated.

In the anthracite coal mines of Pennsylvania, by means of electrification and the supply of superpower, a conservative estimate based on actual tests shows a saving of 6,500,000 gross tons of anthracite. The Survey is at present preparing estimates on the cost of completely electrifying the anthracite mines.

The data required of the Industrial Division will be ready by May 1, for assembly in its final form.

Utilities

A large saving of coal can be effected through the more efficient generation of power by the new superpower stations. The Survey finds that the average rate of coal consumption for present central station output is $2\frac{3}{4}$ lb. per kw.-hr. Power can be produced in the superpower system at an average rate of $1\frac{3}{4}$ lb. per kw.-hr. The present central station output of coal-generated power within the zone is 8,000,000,000 kw.-hr. Therefore 1 lb. saved per kw.-hr. will conserve 4,000,000 tons of coal annually.

Electric Power Generation and Transmission

The location of the large superpower stations and their attendant transmission lines is related to the establishment of load centers throughout the superpower zone to which power will be transmitted from them at minimum distance.

To date it is indicated that about twenty load centers will be established. Early in March sufficient data will be at hand to establish these load centers, after which the location of new superpower stations and their interlinking transmission systems can be promptly determined within the zone.

The development of power outside of but for transmission to the zone is being most carefully considered, having relation to the St. Lawrence River, other hydroelectric powers and the bituminous coal mines. It has been agreed among the experts of the country that 250,000 volts will be an acceptable voltage for the transmission of power from distances greater than 200 miles and at about half that value for the zone itself.

A conference with the coal authorities indicates that a fair figure to take for the average price of coal during the period 1919 was $2.90 per ton at the mine, and during the period from that date to 1930, $3.50 per ton.

With regard to water power for the zone, a summation of the possible outputs from the Potomac, Susquehanna, Delaware, St. Lawrence (American rights), Raquette and the Adirondack powers indicate that for an average year there will be available 12,000,000,000 kw.-hr., and for a minimum year 8,360,000,000 kw.-hr., the plant capacity being 2,300,000 kw. to furnish this amount of energy. It is of interest at this point to state that in 1930 the total power requirement in the superpower zone indicated by projected growth curves will be 48,000,000,000 kw.-hr., of which amount the superpower system could supply 36,000,000,000 kw.-hr. This, therefore, indicates that the water-power supply can be but from 20 to 25 per cent of the total. This fact forces the conclusion that most careful consideration must be given to the efficient development of power from coal.

The report will contain a chronology indicating time and location of superpower stations to be constructed in the order of their requirement, giving savings to be effected as their serial installation is made.

Through the unusual co-operation of the public utilities, the railways and the industries, the completion of the work will be, after May 1, substantially a matter of computation and tabulation.

The legislative and financial aspects of the survey include many important problems such as the formation of a corporation and the method of financing it. These will be considered in detail in the final report which is expected to be ready by June 30, 1921.

Current Events
in the Chemical and Metallurgical Industries

Plans for Annual Meeting of T.A.P.P.I.

Several reports of unusual interest and value will be presented at the annual meeting of the Technical Association of the Pulp and Paper Industry which opens at the Waldorf-Astoria Hotel, New York, on Tuesday, April 12.

Pulverized Fuel and Steam Economy

The committee on heat, light and power is planning a symposium on powdered fuel and steam economy. The leading paper in the symposium will deal with certain definite conditions in steam plants, and discussion will afterward be centered on individual problems in different mills. The chairman of this committee is Howard S. Taylor, of the Management Engineering & Development Co., City National Bank Building, Dayton, Ohio.

An illustrated paper on waterwheel testing, based on the results of twenty years' experience in testing waterwheels in the grinder rooms of mills in the United States and Canada, will be presented by a New England expert who has developed a simple scheme of showing results and indicating methods of operating to insure maximum efficiency.

Report on Groundwood Process

The committee on groundwood, or mechanical pulp, headed by W. A. Munro, of the Wisconsin River Paper & Pulp Co., has conducted a searching investigation into the merits of the Hall process of grinding wood, and a most suggestive and valuable report has been compiled from communications made by users or licensees of the process. The subject has been investigated from three angles—that of the grinder room, of the paper machine room and of the pressroom. The resistance of paper made from Hall process pulp to strain in turning the angle bars of big newspaper printing presses forms part of the study, the committee being in possession of several interesting letters from the pressrooms of the larger dailies.

Plans for Dye Investigation

Ross Campbell, department of technical control, American Writing Paper Co., Holyoke, Mass., has been named by President Hatch to succeed Dr. Otto Kress as chairman of the committee on dyestuffs. One of the first tasks of this committee will be to check up the chapter on dyes in the vocational education textbook. The dyestuffs committee has some ambitious plans for reporting on the performance of different dyes under different conditions, their peculiarities, different combinations in which special dyes should or should not be used, etc.

Individual Papers in Prospect

Among contributions to the session on scientific papers, one is promised from the Forest Products Laboratory dealing with a new method of pulping in which the cooking time is shortened by preliminary impregnation. A number of individual papers will be presented on such subjects as methods of drying paper on paper machines, the testing of crude rosin, measuring moisture in chips for cooking, facts and figures on power required for paper machines, etc.

Army Needs Commissioned Personnel

Competitive examinations will be held April 25 to fill [illegible],585 vacancies in the commissioned personnel of the army. There is a particular desire at this time to obtain as many technical men as possible. There are more than 4,000 vacancies in the army, but only a portion of them will be filled at this time. Among the vacancies to be filled at this examination are thirty-two in the Chemical Warfare Service.

Distribution of Industrial Stocks

A recent issue of the *Boston News Bureau* gives in tabular form a three-year comparison of the total number of stockholders in leading industrial firms. The data given in regard to the following chemical and metallurgical organizations show how these "partners" of big business have increased in number in recent years.

	—Number of Stockholders—		
	1921	1920	1919
Am. Agricultural Chemical com	6,806	5,898	3,515
Am. Agricultural Chemical pfd	8,225	7,930	7,382
Am. Car & Foundry com	6,527	5,023	4,155
Am. Car & Foundry pfd	8,414	8,206	8,004
Am. Hide & Leather com Am. Hide & Leather pfd	*2,524	*1,701	*1,596
Am. Locomotive com	2,456	1,877	2,173
Am. Locomotive pfd	7,411	7,083	7,019
Am. Smelt. & Rfg. com	5,211	4,639	4,006
Am. Smelt. & Rfg. pfd	10,249	9,535	9,030
Am. Sugar Refining com	11,573	10,257	10,683
American Sugar Refining pfd	13,246	12,853	12,649
Anaconda Copper	31,010	29,714	28,385
Bethlehem Steel com	1,160	1,127	1,259
Bethlehem Steel com B	6,082	4,306	4,459
Bethlehem Steel 8% pfd	10,161	9,203	7,600
Bethlehem Steel 7% pfd	544	505	486
Calumet & Arizona Mining	7,900	7,950	7,750
Central Leather com	3,813	3,216	2,963
Central Leather pfd	6,495	6,071	.....
Chile Copper	5,800	5,240	4,300
Chino Copper	8,500	.....	6,403
Copper Range	6,945	6,640	6,508
Crucible Steel com	1,086	946	1,363
Crucible Steel pfd	4,178	3,934	3,858
Cuba Cane Sugar com	2,204	2,584	1,860
Cuba Cane Sugar pfd	5,755	4,880	4,494
East Butte Copper	2,332	2,200	2,233
General Asphalt com	1,043	559	440
General Asphalt pfd	836	1,453	1,709
General Electric	21,000	17,500	16,500
Goodrich Co. (B. F.) com	6,735	3,759	4,589
Goodrich Co., pfd	6,496	4,669	2,454
International Nickel com	13,205	14,353	14,708
International Nickel pfd	1,349	1,300	1,350
Invincible Oil	1,756	1,223	.....
Kelly-Springfield Tire com	1,558	676	890
Kelly-Springfield Tire pfd	1,198	893	339
Lackawanna Steel	3,302	2,372	2,670
Mexican Petroleum com	1,077	805	290
Mexican Petroleum pfd	473	465	482
Middle States Oil	8,500	.....	.....
National Enamel & Stamp com National Enamel & Stamp pfd	*2,252	*2,529	*2,949
National Leather	‡36,500	32,500	.....
Pan-American Pet com	2,495	1,546	707
Pan-American Pet com B	2,831	460	.....
Penn Seaboard Steel	1,450	1,200	1,100
Republic Iron & Stl com	3,300	2,100	2,500
Republic Iron & Stl pfd	5,000	4,900	4,600
Sinclair Consolidated Oil	24,396	13,468	9,928
Swift & Co	†40,000	35,000	24,600
Texas Co	13,465	11,838	5,367
U. S. Food Products	1,759	1,355	1,505
United States Rubber Co. com	11,878	5,015	4,009
United States Rubber Co. pfd	17,353	15,851	15,030
United States Steel Corp. com	95,776	74,318	72,774
United States Steel Corp. pfd	80,534	77,910	80,120
Utah Copper	7,400	6,100	5,700
Westinghouse Electric com	21,564	16,785	14,257
Westinghouse Electric pfd	1,631	1,590	1,552
Worthington Pump com	1,718	1,518	1,637
Worthington Pump pfd A	1,671	1,646	1,511
Worthington Pump pfd. B	1,262	1,115	954

* Total of all stockholders. † Exclusive of over 10,000 employees buying stock on installment plan. ‡ Approximately.

In many organizations a substantial percentage of the stock is now owned by employees. Thus, the United States Steel Corporation reports a total of 160,300 stockholders as of Jan. 31, 1921, 66,506 being employees who own stock outright. This does not include a large number of employees who are buying stock on the subscription plan.

Civil Service Examinations

Until further notice applications will be received by the United States Civil Service Commission on Form 1312 for the positions of: Associate physicist qualified in physical metallurgy, at a salary ranging from $2,000 to $2,800 a year; assistant physicist qualified in physical metallurgy, at a salary ranging from $1,400 to $1,800 a year. Vacancies in the Bureau of Standards, for duty at Washington, D. C., or elsewhere, will be filled from this examination.

Gala Night Planned at Chemists Club

The Chemists Club of New York City is getting ready for a gala night which will fall on March 17—St. Patrick's day. The purpose of this is by no means to establish the greatest of all snake charmers as the patron saint of chemists. There is no legend in connection with the great Scotchman, who went to Ireland and did *not* settle down in Belfast or Londonderry, to indicate that he had any interest whatever in the philosophy of matter. It is the tenth anniversary of the date in 1911 when the club moved into its present splendid quarters, and the trustees have planned a celebration.

The meeting is restricted to members of the club, and begins with a dinner without speeches at which the following gentlemen, made honorary members at the last general meeting, or, in the event of their inability to be present, duly accredited representatives from the embassies of their governments, will be the guests:

Giacomo Cimician, of Italy; Henri Louis Le Chatelier, of France; John Uri Lloyd, of Cincinnati, Ohio; William Henry Nichols, of New York, N. Y.; Edgar Fahs Smith, of Philadelphia, Pa.; Ernest Solvay, of Belgium; Sir Edward Thorpe, of England; Edward Weston, of Newark, N. J.

After the dinner honorary membership will be formally conferred upon the gentlemen, following which there will be an address by Irving Langmuir and Jacques Loeb on subjects not yet specifically announced, but relating to developments in chemistry, from the standpoints of pure science and biology. This will take place in Rumford Hall, and after the meeting there will be a reception to the new members and their representatives in the club parlors.

The occasion promises to be memorable and to contribute a note in the history of chemistry in America.

Chicago Section, A.C.S., Meeting

The Chicago Section of the American Chemical Society met at the City Club Feb. 18 for dinner, followed by a business meeting. Several amendments to the constitution were passed by unanimous vote of the members present. The principal one of these provided for changing the name of the *Chicago Chemical Bulletin* to the *Chemical Bulletin*. While the latter has headed the organ of the Western sections for some time, this action officially confirmed the name.

The address of the evening was delivered by Dr. L. V. Redman, who spoke on phenol condensation products, treating the subject from a practical standpoint. He reviewed the history of the development of synthetic resins from the work of Bayer in 1873. Smith of England took out the first patents in 1899, followed by Luft in Austria. Story, Claypool and Baekeland carried the work down to present developments. He spoke highly of Dr. Baekeland's work in building up a large commercial organic chemical institution which turns out excellent products. The history and details of synthetic resin production are confined almost wholly to patent literature.

He outlined the processes of manufacture now in vogue and exhibited many samples where the resins are useful in the arts. The modern automobile, airplane and other electrical machinery with comparatively high tension require insulations made from these resins compounded with wood flour, asbestos, cambric, etc.

The unusually large attendance of the second largest section at this meeting was in the nature of an ovation to the speaker. Redmanol cigar holders were served as favors at the dinner.

Production of Ore in Soviet Russia

From official Russian sources it appears that the mines of Kriwoi-Rog, which before the war contributed about three-quarters of the whole Russian iron production, have in the last year produced nothing.

The production of the copper mines has dwindled down to insignificance. The production of lead is 10 to 25 per cent that of the pre-war output.

The total of iron-ore production in 1920 was one-tenth of the quantities expected. In the Ural districts only 9,000 workmen, instead of 27,000 before the war, are employed.

Central Leather Co. Report

The annual report of the Central Leather Co. presents a typical case of the extraordinary depreciations in inventories which had such disastrous effects upon the leather industry during 1920. The report shows a loss, after charges and taxes, of $22,428,214. This compares with a surplus of $14,288,481 in 1919, which was equivalent after deducting preferred dividends to $30.11 a share on common. Conditions during 1920 are summarized in the report as follows:

> Distinct advance in price of raw material and finished leather, which was resumed in December, 1919, continued and increased during first two months of 1920. Our sales and advance orders in January and February of last year for active domestic consumption exceeded our supply and our production for some months in advance and raw material was therefore provided.
>
> The abnormally severe winter, almost complete breakdown of transportation system of the country, delays in delivery and cancellation of orders with cessation of retail buying, all worked to produce by early summer a condition of almost complete stagnation in our industry, in common with or possibly beyond that in others. This situation made impossible a liquidation so obviously advisable.
>
> Confronted by this condition—which, in short, resulted in a precipitate fall in price of raw material and practically no market for finished products—the management decided on the drastic policy of almost complete closing of its tanneries. From May until November we reduced purchases of hides to a minimum and liquidated inventories where possible. Not until November, when prices had reached or passed pre-war levels, did we again purchase hides in quantity. During this period the prices of finished products declined on a very restricted market. Inventories of finished products—necessarily large in a company of our size—have been marked down successively to meet the market declines. Result has been an inventory loss on leather sold and unsold, which has absorbed a very great part of the surplus. On Dec. 31, 1920, this company had practically no commitments for purchase of raw materials.

Directory of Petroleum Refineries Issued

A complete directory of petroleum refineries in the United States has just been issued by the United States Bureau of Mines. The report, compiled by H. F. Mason, petroleum economist, states that there are 415 completed refineries in the country, as compared with 373 in 1920. In addition, 44 refineries are in process of construction. The present daily capacity of all refineries is 1,888,800 bbl. of oil, as against a daily capacity of 1,530,565 bbl. in 1920. Texas, with 70 refineries, has the largest number of plants now in operation. Oklahoma has 68, Pennsylvania 51 and California 39 operating refineries. The daily capacity of the Texas refineries now operating is 330,800 bbl.; that of the California refineries is 312,700 bbl.; of the Oklahoma refineries, 248,050 bbl.; while New Jersey, with only 7 refineries operating, has a daily capacity of 215,500 bbl. The report contains data regarding the capacity and type of each plant listed as well as information as to whether at present in operation.

Copies of the report may be had by applying to the Director of the Bureau of Mines, Washington, D. C.

Copper Specifications Submitted for Approval

The American Society for Testing Materials has submitted the following copper specifications to the American Engineering Standards Committee for approval:

> Specifications for soft or annealed copper wire (B3-15).
>
> Specifications for Lake copper wire bars, cakes, slabs, billets, ingots and ingot bars (B4-13).
>
> Specifications for electrolytic copper wire bars, cakes, slabs, billets, ingots and ingot bars (B5-13).
>
> Methods for battery assay of copper (B34-20).

The committee (at 29 West 39th St., New York City) would be very glad to learn of the extent to which these specifications are made use of; and to receive any other information regarding the specifications in meeting the needs of the industry.

Petroleum Production of the World for 1920

The estimated world's production of petroleum in 1920 is 688,474,251 bbl., against 554,505,048 bbl. in 1919, according to figures assembled by the American Petroleum Institute. This represents a gain of 133,969,203 bbl., or 24.2 per cent.

Of the total production in 1920 the United States supplied 443,402,000 bbl., or 64.4 per cent. Mexico supplied 159,-800,000 bbl. (based on exports of that amount plus production marketed at home), or 23.2 per cent of the world's output.

By far the greater gains were made by the United States and Mexico. United States production increased from 377,719,000 bbl. in 1919 to 443,402,000 bbl. in 1920, a gain of 65,683,000 bbl., or 17.4 per cent. Mexico increased from 87,072,954 bbl. to 159,800,000 bbl., a gain of 72,727,046 bbl., or 83.5 per cent.

The estimated production by countries follows:

	1920	1919
United States	443,402,000	377,719,000
Mexico	159,800,000	87,072,954
Russia	30,000,000	34,284,000
Dutch East Indies	16,000,000	15,780,000
India	8,500,000	8,453,800
Rumania	7,406,318	6,517,748
Persia	6,604,734	6,289,812
Galicia	6,000,000	6,255,000
Peru	2,790,000	2,561,000
Japan and Formosa	2,213,083	2,120,500
Trinidad	1,628,637	2,780,000
Argentina	1,366,926	1,504,300
Egypt	1,089,213	1,662,184
France	700,000	....
Venezuela	500,000	321,396
Canada	220,000	220,100
Germany	215,340	925,000
Italy	38,000	38,254
Total	688,474,251	554,505,048

1921 Convention and Exhibition, American Society for Steel Treating

The third annual convention and exhibition of the American Society for Steel Treating will be held during the week of Sept. 19-24 at Indianapolis.

The Manufacturers' Building, on the State Fair Grounds, will be used for exhibits. It is 360 ft. in length, by 220 ft. in width; the central section of this building, measuring 240 x 100 ft., is known as the "Sunken Garden," and is 20 in. below the level of the surrounding floor space. The booths along the north wall are to be used for the live exhibits and are supplied with gas and compressed air, while arrangements have also been made for the exhibitors who require heavy electrical current to be on the promenade on the same side of the building.

Meetings are to be held in the Women's Building, located about 400 ft. from the exhibition hall, where there will be available three or more large meeting rooms.

The Indianapolis chapter of the Society is actively engaged in making comprehensive plans to insure the success of the project.

Peruvian Centennial Expositions

This year the Peruvian Government will celebrate the centennial of Peruvian independence, and approximately $3,000,000 has been voted for this purpose. In connection with the centennial it has been arranged to hold an exhibit of manufactures of other countries and to this end the Peruvian Government has granted concessions to the Peruvian Centennial Exhibits Co., 42 Broadway, New York, and to A. Smeraldi, of Lima, Peru. Information relative to allocation of space and rental charges can be obtained from them.

The buildings in which the two expositions are to be held will very probably be centrally located in the city of Lima and the expositions will undoubtedly be of great interest to consumers and merchants throughout Peru.

British Embargo on Fertilizers

The British Board of Trade has prohibited the exportation of ammonium sulphate, superphosphate, lime, basic slag, and compound fertilizers containing any of these products. This embargo is made under the fertilizer act, 1920, and has been in effect since February 7, 1921.

Book Reviews

FUEL OIL IN INDUSTRY. By *Stephen O. Andros.* 244 pp. Chicago: The Shaw Publishing Co. Price, $3.75.

This is an exposition of the qualities of fuel oil and methods of testing, storing and burning it, together with a description of its application to domestic and industrial furnaces. The book gives a concise and informative account of present-day American practice, and hence fills a gap which has existed in the literature of fuels; it is a satisfactory treatise and merits a good reception.

There are some evidences of haste in the preparation of the manuscript of the book for publication and certain of the chemical considerations are in need of revision, but the author undoubtedly will correct these minor defects in the second printing. It also may be pointed out here that, from the standpoint of the engineer, it would be desirable to give more attention to the subject of the function of oil burners in the operation of furnaces. Some one has said that "a properly designed oil furnace is in reality a combination of a gas producer and a furnace," and that "progress has been slow in the efficient use of oil fuel because more is not known about gas producers." The reviewer recently has had occasion to study the practices in heat-treatment and it is clear that there is a prevailing lack of appreciation of the differences between "burning oil," "making heat" and "properly applying heat to obtain a uniformly heated product." It seems to the reviewer that progress in the economical use of oil fuel has been retarded principally by improper furnace design and operation. Generally speaking, the various method of burning oil are similar, based upon the same principles, and learned easily.

W. A. HAMOR.

* * *

THE JOURNAL OF THE INSTITUTE OF METALS, Vol. XXIV. Edited by *G. Shaw Scott,* Secretary of the Institute of Metals, 36 Victoria St., London, S. W. 1. Price 31s. 6d. net.

This second volume for 1920 contains about 550 pages of text, printed and edited in the usual excellent style. It contains the papers read before the meeting held in the middle of September, together with 100 pages devoted to abstracts of current literature on non-ferrous metallurgy. In timely publication it may well set an example to American societies.

Perhaps the contribution which has attracted most attention and drawn forth the most discussion is that by Miss Elam and Prof. Carpenter on Recrystallization, a paper which was abstracted in this journal on page 224 of the issue for Feb. 2. Another important paper discussing gases contained in brass (by Messrs. Banford and Ballard) was abstracted in this journal for Jan. 19, 1921, page 132. Other papers of interest to metallurgists controlling manufacturing operations set forth various phases of brass manufacture, the constitution of bearing metals and defects in admiralty bronze. For those more interested in research work and in theoretical metallurgy, Miss Bingham of the National Physical Laboratory has contributed a notable article on the allotrophy of zinc, while D. Hanson and Miss Gayler have written an extended paper on "The Constitution of the Alloys of Aluminum and Magnesium." The latter contribution is a part of an extended research undertaken by the National Physical Laboratory during the war into the nature of aluminum alloys. Doubtless further results of this painstaking investigation will be published in due time.

This volume also contains the text of the 1920 May lecture delivered by Dr. Carl A. F. Benedicks, on "The Recent Progress in Thermo-electricity." Nearly all of the work as done by Prof. Benedicks and his associates has been published in detail in various physical journals, but in the present instance he collects the main arguments in words not too technical, only alluding briefly to the numerous necessary precautions. Altogether this makes a very interest-

ing account of his brilliant experimental demonstration that thermo-electric currents occur in strictly homogeneous metals—even liquid mercury—as a function of the temperature distribution only, currents of the same magnitude as those of the Seebeck effect. The wide application of thermo-electric pyrometers for engineering work arouses interest in the possible practical uses of these investigations.

A considerable portion of the text is descriptive of work which has gone forward at the National Physical Laboratory, the British counterpart of our Bureau of Standards. Naturally one would expect an extremely high class of work from such an institution, but the quality of the other papers published in the volume does not suffer in the least by comparison. A further point of note is that no less than three of the eleven papers were written either in whole or in large part by women. Evidently the metallurgiste has arrived. E. E. THUM.

Personal

HOWARD C. ARNOLD, well known in ceramic circles, has recently joined the staff of Arthur D. Little, Inc., Cambridge, Mass. After the war Mr. Arnold studied optical glass at the Bureau of Mines for a short time, and then became chief chemist and plant manager of B. F. Drakenfeld & Co., New York City, where he was chiefly concerned in developing ceramic materials, especially the coloring oxides.

CYRUS E. FRYE has been elected president of the Lincoln Paper Mills Corporation, Elkhart, Ind., to succeed Edward B. Zigler, deceased. Mr. Frye has been in active management of the company for the past year.

ARTHUR L. TUTTLE, who directed the building of one of the largest fertilizer plants at Atlanta for the Tennessee Copper & Chemical Corporation, has returned to New York headquarters.

SAMUEL WANDER, general manager of S. Wander & Sons, New York, has returned to the city after a month's absence at Palm Beach and Miami, Fla., and in Cuba.

Obituary

DANIEL BAUGH, president of Baugh & Sons Co., Philadelphia, manufacturer of animal oils and fertilizers, died on Feb. 28, at Palm Beach, Fla. Mr. Baugh was eighty-five years old and well known in the philanthropic, chemical and commercial circles of Philadelphia.

ROBERT HOLBROOK, chief chemist of the Victor Chemical Works at Chicago, Ill., died at Los Angeles, Cal., on Feb. 11, at the age of thirty-six. He had been in failing health for the past two years and had gone to California to recuperate. He was a graduate of the University of Michigan (1906), a member of the American Chemical Society and the Chicago Chemists' Club, and was recognized as an authority on phosphoric acid and allied products.

WILLIAM A. JONES, president of Richards & Co., manufacturer of Zapon pyroxylin products, died on Friday, Feb. 18, at his home in Tuckahoe, N. Y. Following his graduation at Hillsboro, N. C., he studied under Prof. Ira Remsen at Johns Hopkins. After receiving his doctor's degree, he became associated with Commodore Leonard Richards, who at the time was operating one of the pioneer pyroxylin works, the Boston Artificial Leather Co., which was subsequently reorganized and moved to Stamford, Conn., under the firm name of Richards & Co., and in 1918 taken into the Atlas Powder Co. organization. Dr. Jones was known as the "Dean of the Industry," through his lifelong devotion to the chemistry of pyroxylin solutions and artificial leather. His wife and sister survive him.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, March 4, 1921.

Intermittent periods of dullness and activity characterized trading in the chemical market during the past week. In spite of recent pessimism, however, it is generally agreed that February was the brightest month since the present period of depression. Margins of profit have not been comparable with those of 1920, but the volume of business has been in some cases greater than that of February of last year. The characteristic point of difference between the two periods is the lack of repeated turnover which was so general a year ago. The market this year seems to have been based on business direct from manufacturer or importer to consumer, while business last year was carried on through a multiplicity of intermediate hands, each of whom took his profit from every individual transaction.

Sentiment is steadily improving and while price trends are still downward on account of competitive selling of foreign goods, it is generally conceded that the next three months will see business on a sound normal basis again. The readjustment of quotations recently made by manufacturers has not been altered to an appreciable degree. Consumers are still operating cautiously with the idea that more attractive prices may be established later on. There are three great factors, however, hindering any noticeable readjustments and these are the high freight rates, high coal prices and high wages. Other factors are contributors to the general result, but the removal of the three named would open the way for permanent progress and disperse any doubts which still cling to the chemical industry. Second hands who refuse to take their losses on old contracts know there is a potential shortage of goods which would develop into a real shortage with any noted improvement in trade conditions.

Light *soda ash* held quite steady on the spot market and while an isolated car was occasionally sold at a price concession, most dealers held single bags at \$2.05@\$2.10 per 100 lb. Barrels were quoted by dealers at \$2.20@\$2.25. The absence of any live export business left the price for resale ash in double bags at \$2.10. Producers' views are unchanged at \$1.72½ per 100 lb., basis 48 per cent, f.o.b. works, in single bags for prompt and future shipments. *Prussiate of soda* has attracted some interest, mainly because the market was flexible, and prices have receded under spirited competition from holders of imported goods. Spot prices have shown irregular weakness, with foreign material offered down to 14½c. per lb., with a possibility of shading on firm business. Forward shipments were offered at 14c. per lb.

Standard 99 per cent *copper sulphate*, large crystals, could be purchased at lower prices from producers and business is reported in carlots on a basis of 5¾c. per lb. The small crystals, 98½-99 per cent, were offered by first hands at 5½c. per lb. Smaller quantities of both varieties commanded a slight premium depending upon the size of the order. The lower prices in this commodity are directly the result of the decline in the course of production which is made possible through lower copper quotations. While the South American inquiry is practically at a standstill at the present time, a demand has developed for shipment to Europe, particularly to Italy and France and other grape-growing countries. European buyers who should have bought their requirements a few months ago have stayed out of the market as long as they could with the idea of getting material at a lower figure. The approach of the season for insecticide users has stimulated this foreign inquiry. Germany is competing for this business, but it seems that American sulphate is far superior and holds the preference.

Resale lots of domestic *caustic potash*, 88-92 per cent KOH, were on the market at prices ranging from 10@11c. per lb. Large quantities of this material have been returned from abroad during the past few months and these

are responsible for the relatively low prices prevailing. Large producers of *chlorate of potash* are asking 15c. per lb. for the domestic quality for prompt shipment from works. Importations of various grades are on the market at prices ranging from 8c. per lb. upward, depending upon the seller. Most of this material came from Germany and was manufactured during the war. The quality in many cases has been so irregular that consumers have not shown any unusual interest in the product, regardless of the comparatively low prices quoted.

Small lots of *bichromate of soda*, standard brand, were heard from 8@8½c. per lb. Transactions were reported at 8@8¼c. Buyers are only taking small lots at intervals and show little disposition to operate in any large way for prompt and future shipments. Resale offerings of this material do not appear too plentiful, but there is enough competition among second hands to keep prices moderately irregular. *Bleaching powder* has been sold quite freely to paper mills and bleacheries on the basis of 2½c. per lb., f.o.b. works, in large drums. Importers are meeting this figure with offerings of foreign bleach and have been quite successful in disposing of large quantities over the year.

Resellers of spot *carbon tetrachloride* are quoting the market as low as 10c. per lb. Producers are quoting up to 12c. Stocks in second hands are not large. Technical *magnesium sulphate* is very scarce on the spot, with nominal quotations around $1.70 per 100 lb. Arrivals are quoted around 1¼c. per lb. Prices on *ammonia alum* have been reduced by leading manufacturers, who are quoting on a basis of 4¼@4½c. per lb. for the lump variety. Business has been done in a limited volume only. Prices were recently reduced on *nitric acid*. The new prices are given as 5¾@6¾c. per lb. for the 36 deg. in carboys, 6¼@7¼c. for the 38 deg., 6¾@7¾c. for the 40 deg. and 7½@8½c. for the 42 deg. Business continued along narrow lines, although the total quantity of acid changing hands is said to be good.

Coal-Tar Products

The reports of different quarters of the coal-tar products market during the past week have been very much mixed. Some sellers have found an improvement, while others say they can find no change in the dullness that has been steadily manifest for weeks. The increased number of textile plants which have been put into operation during the past month or so will unquestionably result in a growing demand for colors, but so far this increased demand has failed to reach intermediate manufacturers. In no section of the market have second hands figured so largely as in this and before a real improvement can come in business it will be necessary to reduce the number of profits on a single transaction to a minimum. Basic conditions in this market are decidedly in favor of the American manufacturers in being protected, at least for the time being, from any form of foreign competition which has been such a factor in the chemical market. The actual volume of business during the past month has been better than the attitude sellers seem to indicate, since they are chiefly concerned over the fact that prices have been sacrificed in a great number of cases. Prices in general continued soft, with resale lots of many commodities in more or less distress. The crude products seem to be moving in large volume but still confined to quantities covering short periods. Prices in this branch of the market are holding more steady than the intermediate market and now that better demand is in prospect the present quotations have an air of firmness.

Prices on *benzene* continued practically unchanged. The demand has been somewhat more active, but is still below normal, especially for carlot business. Quotations are given as 30@35c. per gal. for the pure grade and 28@34c. for the 90 per cent in tank cars and drums. The inactivity in the dye trade, which has prevented any considerable amount of business recently, is passing and increased activity among dye makers will bring about a revival of interest in this commodity, as stocks in consumers' hands are conspicuously low. The *naphthalene* market in second hands is reported considerably strong. The flakes can still be found in some quarters as low as 8c. per lb., but the majority of holders of spot goods are setting their selling price at 8½c. per lb. Producers are quoting 9@10c. on flakes and 10@11c. on balls, all f.o.b. works.

Some inquiry for *aniline oil* has been noted during the week, but prices are still very unsteady and are quoted over a wide range by holders of stocks. Resale stocks are available at 22c. per lb., drums extra. Producers are quoting all the way up to 28c. per lb. The increased volume of business being done by the textile industry is expected to reflect itself in the market in the very near future. The market on *beta-naphthol* has been of a very limited nature during the week, but has shown some improvement over other weeks. Holders are quite firm on price and have turned down bids of 32@33c. per lb. for spot material. The general quotation for resale material is 34c. per lb., with producers' figure ranging from 40@45c. per lb.

Resale lots of *para-nitraniline* are offered as low as 85c. per lb. Producers are quoting $1.05@$1.15 per lb., according to quantity, but are willing to shade these figures on firm business. Factors report a limited routine demand for *ortho-toluidine*. The available supply is of sufficient volume to meet present requirements and sellers are steady in their views on prices, ranging from 25@30c. per lb. Trading in the market on *para toluidine* continues along quiet lines with the movement chiefly confined to small quantities into consuming channels. Prices are fairly steady at $1.40@$1.50 per lb., depending on quantity. Prices on *H acid* are still heard over a rather wide range. Producers are holding for as high a figure as $1.60 per lb. for limited amounts and name $1.50 for round lots. Outside holders are quoting all the way down to $1.10 per lb. for a fair quality. Other quotations generally heard ranged from $1.25@$1.35 per lb.

Vegetable Oils

Importers of *China wood oil* report quiet trading, with prices in some quarters unsettled. It was reported that scattered lots could be picked up at 9½c. per lb. in barrels, while for carlots for nearby delivery 9c. could be done on a firm bid. The Coast market was nominal at 8c. per lb. Reports on the conditions on *coconut oil* covering round lots were rather conflicting. In some quarters it was said that the situation was somewhat firmer, while advices from the Middle West indicate that offerings were made at concessions. Ceylon grade in barrels closed at 9¾c. per lb., while Cochin closed at 10½c. per lb.

The market for *linseed oil* was dull and the undertone, taken as a whole, was barely steady. A few inquiries came to light, but these were more or less in the nature of sounding sellers. So far as nearby oil is concerned, it was possible to draw offerings from crushers on a basis of 67c. per gal. in carlots, while in a few cases firm bids could have bought merchandise at some concession. Spot oil in lots of 5 and 10 bbl. was available at 70@71c. per gal. The market for *palm oil* was reported quiet and unchanged at 7¼c. per lb., immediate or prompt shipment. *Niger oil* held at 6½c. per lb. The steady position of the exchange tends to hold values on this commodity. There were offerings of domestic crude *peanut oil* for immediate shipment from mill at 6c. per lb., indicating that the market was somewhat irregular. The demand in general was reported dull.

The Iron and Steel Market

Pittsburgh, March 4, 1921.

On the whole there is perhaps a slight downward trend in finished steel according to minimum prices quoted by independents, but the outstanding feature of the market situation is the fact that prices are declining so little when all or nearly all of the independents are willing to make further cuts in prices for the sake of getting an actual tonnage of orders. The difficulty is that consumers are unwilling to buy at any price. Repeatedly mills have solicited buyers to make bids, only to be met with the response that no steel is required just now.

The Pittsburgh Steel Co. has begun to quote wire nails at $3 base, or 25c. a keg under the Steel Corporation price. Several weeks ago the Midvale Steel & Ordnance Co., which is generally credited with having instituted the price-cutting movement, began to quote nails at $3.10, but subsequently the price was withdrawn, at least as an open quotation. The

Pittsburgh Steel Co., however, explains that it quotes $3 openly because at least two other producers have been quietly doing $3 of late.

Plates are still quotable at 2.10c. on ordinary business, bars at 2c. and shapes at 2.10c., though in each case it is understood that on a sufficiently attractive order $1 or $2 a ton less could be done, the difficulty being that attractive orders are not being offered in the market. An interesting point is that the Steel Corporation has just sold 3,000 tons of plates to a regular customer at its price of 2.65c.

Black sheets are quoted at 4.10c. by more producers than formerly, with intimations that 4c. could be done on a sufficiently attractive order. Galvanized sheets are generally quotable at 5.25c., with likewise a little leeway.

Report has it that standard railroad spikes could be bought at 3.35c., against 3.65c., the regularly quoted price, hot-rolled strips at 3.05c. or less, against 3.30c., and cold-rolled strips at 6c., against 6.25c. Cold-finished steel bars can be purchased even in less than carload lots at 3.35c., against a nominal or official quotation of 3.60c.

Steel Corporation Position

The United States Steel Corporation evinces no intention or reducing either its prices or its wage rates immediately. Some of the corporation's customers have expressed themselves as opposed to price reductions at this time and there is no evidence that buyers in general are waiting for lower prices or would be induced to buy more freely even if prices were greatly reduced. As to wages, which obviously could not be reduced when shipments are being made at old prices, the cost of living has not declined sufficiently to permit of a fair and permanent readjustment being made. With light operation and a distribution of employment the earnings of the men are reduced while the cost of living has not greatly declined.

Production

Operations at some of the independent mills have increased, but on the whole there is no increase, and common estimates are that the independents generally are not operating at over 20 or 25 per cent of capacity, which may be estimated at 30,000,000 gross tons of ingots per annum. The Steel Corporation has been operating this week at between 60 and 65 per cent of capacity, which is approximately 22,500,000 tons. Production therefore may be taken at 7,000,000 tons a year by the independents and 14,000,000 tons by the Steel Corporation, or 21,000,000 tons altogether, which is just 40 per cent of actual capacity as nearly as can be estimated. This rate is undoubtedly in excess of the actual rate at which steel is now being consumed, and however business may be distributed among the mills in the future, the total production is likely to decline for several weeks before there is any tendency toward an upturn.

Production of pig iron is at the rate of 22,000,000 or 23,000,000 tons a year, or 50 per cent of estimated capacity, not theoretical capacity. The merchant furnaces as a whole are producing at not over about one-third of capacity. A considerable part of the output is being stocked, and there are prospects of several merchant furnaces blowing out within the next few weeks. The steel interests do not seem to have reduced their pig iron production in all cases as much as their steel production, and some of them have accumulated tonnages of pig iron that look large in present conditions.

Foundry pig iron has declined 50c. in the valley market, with sales at $26.50 valley. Bessemer remains quotable nominally at $27 valley, with no interest manifested. The last open quotation on basic iron was $25 valley, and merchant furnaces would willingly sell at this price, hoping to reduce costs while operating sufficiently to avoid loss. At best, of course, the $25 price would represent taking a loss on ore bought at last season's prices, it being understood that the 1921 prices will be down, perhaps by as much as $1. Some steel works iron could probably be bought at well below $25, but bids are not being made. It seems to be established that one odd lot of basic of 600 or 700 tons has just been sold at $23 to close out. From all this it can be seen that the pig iron market has not reached a stable level by any means.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... -	$0.55 - $0.60
Acetone	lb.	$0.13 - $0.13½	.13½ - .14
Acid, acetic, 28 per cent	100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent	100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99½ per cent, carboys	100 lbs.	9.00 - 9.50	10.00 - 10.50
Boric, crystals	lb.	.14½ - .15	.15½ - .16
Boric, powder	lb.	.15½ - .16½	.17 - .18
Citric	lb.	..... -	.46 - .48
Hydrochloric	100 lb.	1.45 - 1.60	1.75 - 2.00
Hydrofluoric, 52 per cent	lb.	.15 - .16	.16½ - .18
Lactic, 44 per cent tech	lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech	lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		..... -	..... - .....
Nitric, 40 deg	lb.	.06¾ - .07	.07½ - .07¾
Nitric, 42 deg	lb.	.07½ - .08	.08¼ - .08¾
Oxalic, crystals	lb.	.15 - .15½	.16 - .17
Phosphoric, Ortho, 50 per cent solution	lb.	.15 - .15½	.16 - .16½
Picric	lb.	.30 - .32	.35 - .40
Pyrogallic, resublimed	lb.	..... -	2.30 - 2.40
Sulphuric, 60 deg., tank cars	ton	..... -	..... - .....
Sulphuric, 60 deg., drums	ton	..... -	14.00 - 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 - 19.00	..... - .....
Sulphuric, 66 deg., drums	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys	ton	..... -	..... - .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 - 24.00	..... - .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 - .....
Tannic, U. S. P.	lb.	..... -	1.15 - 1.25
Tannic (tech.)	lb.	.45 - .47	.48 - .50
Tartaric, crystals	lb.	..... -	.32 - .35
Tungstic, per lb. of WO	lb.	..... -	1.00 - 1.20
Alcohol, Ethyl	gal.	..... -	4.75 - 5.00
Alcohol, Methyl (see methanol)		..... -	..... - .....
Alcohol, denatured, 188 proof	gal.	..... -	.46 - .50
Alcohol, denatured, 190 proof	gal.	..... -	.51 - .54
Alum, ammonia lump	lb.	.04¾ - .04½	.04¾ - .05
Alum, potash lump	lb.	.05½ - .06	.06½ - .07
Alum, chrome lump	lb.	.13 - .13½	.14 - .14½
Aluminum sulphate, commercial	lb.	.02¼ - .02½	.02¼ - .03
Aluminum sulphate, iron free	lb.	.03 - .03¼	.03½ - .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 - .07½	.07¼ - .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder	lb.	.12 - .12¼	.12½ - .13
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	.07¾ - .08	.08¼ - .08½
Ammonium chloride, granular (gray salammoniac)	lb.	.09 - .09¾	.09½ - .10
Ammonium nitrate	lb.	.08 - .08½	.09 - .10
Ammonium sulphate	100 lb.	3.15 - 3.20	3.25 - 3.35
Amylacetate	gal.	..... -	4.00 - 4.25
Amylacetate tech	gal.	..... -	3.25 - 3.50
Arsenic oxide, (white arsenic)	lb.	.09 - .09½	.10 - .10½
Arsenic, sulphide, powdered (red arsenic)	lb.	.14 - .14½	.15 - .15½
Barium chloride	ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide)	lb.	.18 - .19	.19½ - .22
Barium nitrate	lb.	.10 - .10¼	.10½ - .11
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calc. hypochlorite)		..... -	..... - .....
Blue vitriol (see copper sulphate)		..... -	..... - .....
Borax (see sodium borate)		..... -	..... - .....
Brimstone (see sulphur, roll)		..... -	..... - .....
Bromine	lb.	.40 - .41	.42 - .45
Calcium acetate	100 lbs.	2.00 - 2.05	..... - .....
Calcium carbide	lb.	.04 - .04¼	.04½ - .05
Calcium chloride, fused, lump	ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated	lb.	.01½ - .01¾	.02 - .02½
Calcium hypochlorite (bleach'g powder)	lb.	.02½ - .02¾	.03 - .03¼
Calcium peroxide	lb.	..... -	1.00 - 1.10
Calcium phosphate, monobasic	lb.	..... -	.15 - .16
Camphor	lb.	..... -	.70 - .75
Carbon bisulphide	lb.	.08 - .08½	.09 - .09½
Carbon tetrachloride, drums	lb.	.10 - .10½	.11 - .12
Carbonyl chloride (phosgene)	lb.	..... -	.75 - 1.00
Caustic potash (see potassium hydroxide)		..... -	..... - .....
Caustic soda (see sodium hydroxide)		..... -	..... - .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 - .09½	.10 - .10½
Chloroform	lb.	..... -	.38 - .40
Cobalt oxide	lb.	..... -	3.00 - 3.10
Copperas (see iron sulphate)		..... -	..... - .....
Copper carbonate, green precipitate	lb.	.24 - .25	.26 - .27
Copper cyanide	lb.	..... -	.50 - .60
Copper sulphate, crystals	lb.	.05½ - .05¾	.06 - .06½
Cream of tartar (see potassium bitartrate)		..... -	..... - .....
Epsom salt (see magnesium sulphate)		..... -	..... - .....
Ethyl Acetate Com. 85%	gal.	..... -	1.00 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%)		..... -	..... - .....
Formaldehyde, 40 per cent	lb.	.17¼ - .17½	.17¾ - .18
Fusel oil, ref	gal.	..... -	4.00 - 4.50
Fusel oil, crude	gal.	..... -	2.50 - 2.75
Glauber's salt (see sodium sulphate)		..... -	..... - .....
Glycerine, C. P. drums extra	lb.	..... -	.19 - .20
Iodine, resublimed	lb.	..... -	3.75 - 3.85
Iron oxide, red	lb.	..... -	.10 - .20
Iron sulphate (copperas)	100 lb.	1.00 - 1.25	1.50 - 1.75
Lead acetate, normal	lb.	..... -	.14½ - .16
Lead arsenate (paste)	lb.	.11 - .12	.12½ - .13
Lead nitrate	lb.	..... -	.15 - .20
Litharge	lb.	.08¾ - .09	.09½ - .10
Lithium carbonate	lb.	..... -	1.25 - .....
Magnesium carbonate, technical	lb.	.10½ - .11	.11½ - .12
Magnesium sulphate, U. S. P.	100 lb.	2.25 - 2.75	..... - .....
Magnesium sulphate, commercial	100 lb.	..... -	1.70 - 2.00
Methanol, 95%	gal.	..... -	1.28 - 1.30
Methanol, pure	gal.	..... -	1.55 - 1.60
Nickel salt, double	lb.	..... -	.12 - .12½
Nickel salt, single	lb.	..... -	.13 - .13½
Phosgene (see carbonyl chloride)		..... -	..... - .....
Phosphorus, red	lb.	.45 - .46	.47 - .50
Phosphorus, yellow	lb.	..... -	.35 - .37
Potassium bichromate	lb.	.13 - .13½	.14 - .14½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ ... – $....	$0.30 – $0.35
Potassium bromide, granular	lb.	..... –	.20 – .40
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, crude	lb.	.08 – .08½	.09 – .10
Potassium chlorate, crystals	lb.	.08 – .10	.11 – .15
Potassium cyanide	lb.	..... –	.45 – .50
Potassium hydroxide (caustic potash)	lb.	.10 – .11	.12 – .13
Potassium muriate	ton	65.00 – 70.00	..... – .....
Potassium iodide	lb.	..... –	2.75 – 3.00
Potassium nitrate	lb.	.09½ – .09¾	.10 – .12¾
Potassium permanganate	lb.	.45 – .46	.48 – .50
Potassium prussiate, red	lb.	.50 – .52	.53 – .55
Potassium prussiate, yellow	lb.	.28 – .29	.30 – .32
Potassium sulphate (powdered)	per unit	..... –	..... – 2.25
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac (see ammonium chloride)		..... –	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	30.00 – 33.00
Silver cyanide	oz.	..... –	1.25 – .....
Silver nitrate	oz.	..... –	.37½ – .38½
Soda ash, light	100 lb.	2.00 – 2.10	2.20 – 2.50
Soda ash, dense	100 lb.	2.20 – 2.30	2.40 – 2.60
Sodium acetate	lb.	.05½ – .05¾	.06 – .06½
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.25
Sodium bichromate	lb.	.08 – .08½	.08½ – .08¾
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.05½ – .05¾	.06 – .06½
Sodium borate (borax)	lb.	.08¼ – .08½	.08¾ – .09
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium chlorate	lb.	.10 – .10½	.10½ – .11
Sodium cyanide, 96-98 per cent	lb.	.20 – .22	.23 – .30
Sodium fluoride	lb.	.13½ – .14	.14½ – .15
Sodium hydroxide (caustic soda)	100 lb.	3.60 – 3.70	3.80 – 4.00
Sodium hyposulphite	lb.	..... –	.03¾ – .04
Sodium nitrate	100 lb.	2.85 –	3.00 – .....
Sodium nitrite	lb.	.06 – .06½	.06½ – .07
Sodium peroxide, powdered	lb.	.30 – .31	.32 – .34
Sodium phosphate, dibasic	lb.	.04½ – .04¾	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.29 – .31
Sodium prussiate, yellow	lb.	.14½ – .14¾	.14¾ – .15
Sodium silicate, solution (40 deg.)	lb.	1.25 – 1.35	1.40 – 1.50
Sodium silicate, solution (60 deg.)	lb.	.03 – .03½	.03½ – .03¾
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.25 – 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	.05 – .05½	.05½ – .06
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.16 – .16½	.16½ – .17
Sulphur chloride, red	lb.	.07 – .07½	.07½ – .08
Sulphur, crude	ton	16.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.08 – .08½	.08½ – .09
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	..... – .....
Tin oxide	lb.	..... –	.45 – .47
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran	lb.	.11 – .11½	.11½ – .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.08½ – .09	.09½ – .11
Zinc sulphate	lb.	.03¼ – .03½	.04 – .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10	— $1.15
Alpha-naphthol, refined	lb.	1.45	— 1.50
Alpha-naphthylamine	lb.	.38	— .40
Aniline oil, drums extra	lb.	.22	— .28
Aniline salts	lb.	.28	— .32
Anthracene, 80% in drums (100 lb.)	lb.	.75	— 1.00
Benzaldehyde U.S.P	lb.	1.00	— 1.50
Benzidine, base	lb.	.95	— 1.05
Benzidine sulphate	lb	.80	— .90
Benzoic acid, U.S.P	lb.	.65	— .70
Benzoate of soda, U.S.P	lb.	.65	— .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30	— .35
Benzene, 90%, in drums (100 gal.)	gal.	.28	— .32
Benzyl chloride, 95-97%, refined	lb.	.30	— .35
Benzyl chloride, tech	lb.	.25	— .30
Beta-naphthol benzoate	lb.	3.50	— 4.00
Beta-naphthol, sublimed	lb.	.70	— .75
Beta-naphthol, tech	lb.	.34	— .40
Beta-naphthylamine, sublimed	lb.	2.25	— 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16	— .18
Ortho-cresol, in drums (100 lb.)	lb.	.23	— .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95	— 1.00
Cresylic acid, 95-97%, dark, in drums	gal.	.90	— .95
Cresylic acid, 50%, first quality, drums	gal.	.60	— .65
Dichlorbenzene	lb.	06	— .09
Diethylaniline	lb.	1.20	— 1.30
Dimethylaniline	lb.	.55	— .65
Dinitrobenzene	lb.	.30	— .32
Dinitroclorbenzene	lb.	.25	— .30
Dinitronaphthalene	lb.	.33	— .35
Dinitrophenol	lb.	.40	— .45
Dinitrotoluene	lb.	27	— .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	38	— .40
Diphenylamine	lb.	60	— .70
H-acid	lb.	1.30	— 1.50
Meta-phenylenediamine	lb.	1.25	— 1.30
Monochlorbenzene	lb.	14	— .16
Monoethylaniline	lb.	1.75	— 2.00
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08	— .08½
Naphthalene, flake	lb.	.08¼	— .08½
Naphthalene, balls	lb.	.09¼	— .10
Naphthionic acid, crude	lb.	.70	— .75
Nitrobenzene	lb.	.12	— .15
Nitro-naphthalene	lb.	.30	— .35
Nitro-toluene	lb.	.18	— .25
Ortho-amidophenol	lb.	3.20	— 3.75
Ortho-dichlor-benzene	lb.	.15	— .20
Ortho-nitro-phenol	lb.	.75	— .80
Ortho-nitro-toluene	lb.	.20	— .24
Ortho-toluidine	lb.	.25	— .30
Para-amidophenol, base	lb.	1.90	— 2.00
Para-amidophenol, HCl	lb.	2.10	— 2.20
Para-dichlorbenzene	lb.	.15	— .25
Paranitroaniline	lb.	.85	— 1.00
Para-nitrotoluene	lb.	90	— 1.05
Para-phenylenediamine	lb.	1.90	— 2.00
Para-toluidine	lb.	1.30	— 1.60
Phthalic anhydride	lb.	.55	— .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10	— .12
Pyridine	gal.	2.00	— 3.50
Resorcinol, technical	lb.	1.85	— 2.00
Resorcinol, pure	lb.	2.30	— 2.50
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.22	— .23
Salicylic acid, U. S. P.	lb.	.25	— .27
Salol	lb.	.85	— .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28	— .32
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.16	— .18
Sulphanilic acid, crude	lb.	.30	— .35
Tolidine	lb.	1.35	— 1.45
Toluidine, mixed	lb.	.40	— .45
Toluene, in tank cars	gal.	.28	— .32
Toluene, in drums	gal.	.30	— .35
Xylidines, drums, 100 gal	lb.	.40	— .45
Xylene, pure, in drums	gal.	.42	— .45
Xylene, pure, in tank cars	gal.	.45	— ....
Xylene, commercial, in drums, 100 gal	gal.	.33	— .35
Xylene, commercial, in tank cars	gal.	.30	— ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24	— $0.26
Beeswax, refined, light	lb.	.27	— .28
Beeswax, white pure	lb.	.40	— .45
Carnauba, Flora	lb.	.68	— .70
Carnauba, No. 2, North Country	lb.	.30	— .32
Carnauba, No. 3, North Country	lb.	.18	— .19
Japan	lb.	19¼	— .20
Montan, crude	lb.	07	— .08
Paraffine waxes, crude match wax (white) 105-110 m.p	lb.	.04¼	— .04¾
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03¾	— .04
Paraffine waxes, refined, 118-120 m.p	lb.	.04¾	— .05
Paraffine waxes, refined, 125 m.p	lb.	.05¼	— ....
Paraffine waxes, refined, 128-130 m.p	lb.	.06¼	— ....
Paraffine waxes, refined, 133-135 m.p	lb.	.07¼	— .07½
Paraffine waxes, refined, 135-137 m.p	lb.	.08¾	— .09
Stearic acid, single pressed	lb.	.12	— ....
Stearic acid, double pressed	lb.	.12½	— ....
Stearic acid, triple pressed	lb.	.13½	— ....

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.70
Pine oil, pure, dest. dist	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.37
Pinewood creosote, ref	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl	280 lb.	$6.25	— .....
Rosin E-I	280 lb.	6.25	— .....
Rosin K-N	280 lb.	6.25	— .....
Rosin W. G.-W. W	280 lb.	6.50	— .....
Wood rosin, bbl	280 lb.	6.75	— .....
Spirits of turpentine	gal.	.59	— .....
Wood turpentine steam dist	gal.	.54	— .....
Wood turpentine, dest. dist	gal.	.53	— .....
Pine tar pitch, bbl	200 lb.	......	— 7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	......	— 14.50
Retort tar, bbl	500 lb.	15.00	— 14.75
Rosin oil, first run	gal.	.45	— .....
Rosin oil, second run	gal.	.48	— .....
Rosin oil, third run	gal.	.60	— .....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naptha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.17	— $0.18
Upriver coarse	lb.	.13	— .14
Upriver caucho ball	lb.	.14	— .14½
Plantation—First latex crepe	lb.	.19	— .....
Ribbed smoked sheets	lb.	.18	— .....
Brown crepe, thin, clean	lb.	.18	— .....
Amber crepe No. 1	lb.	.20	— .....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.08¾	— $0.09
Castor oil, AA, in bbls	lb.	.10	— .10½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.08	— .08¼
Cocoanut oil, Ceylon grade, in bbls	lb.	.09¾	— .10
Cocoanut oil, Cochin grade, in bbls	lb.	.10½	— .11
Corn oil, crude, in bbls	lb.	.08¼	— .08½
Cottonseed oil, crude (f. o. b. mill)	lb.	.05¼	— .05½
Cottonseed oil, summer yellow	lb.	.07½	— .07¾
Cottonseed oil, winter yellow	lb.	.08¼	— .08½
Linseed oil, raw, car lots (domestic)	gal.	.67	— .68
Linseed oil, raw, tank cars (domestic)	gal.	.60	— ....
Linseed oil, boiled, car lots (domestic)	gal.	.69	— .70

Olive oil, commercial	gal.	$2.40	— $2.60
Palm, Lagos	lb.	.07½	— .07¾
Palm, Niger	lb.	.06½	— .06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.06	— .06½
Peanut oil, refined, in bbls	lb.	.12	— .12½
Rape eed oil, refined in bbls	gal.	1.05	— 1.10
Rape eed oil, blown, in bbls	gal.	1.15	— 1.20
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.07¼	— .07½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.04	— ....

FISH

Light pressed menhaden	gal.	$0.46	— $0.48
Yellow bleached menhaden	gal.	.48	— .50
White bleached menhaden	gal.	.50	— .52
Blown menhaden	gal.	.85	— ....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00	— 30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	— 26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00	— 17.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50	— 28.00
Barytes, crude, first grade, Missouri	net ton	10.00	— .....
Blanc fixe, dry	lb.	.05	— .05½
Blanc fixe, pulp	net ton	50.00	— 60.00
Casein	lb.	.14	— .16
Chalk, domestic, extra light	lb.	.05	— .05½
Chalk, domestic, light	lb.	.04½	— .05
Chalk, domestic, heavy	lb.	.04	— .05
Chalk, English, extra light	lb.	.05	— .07
Chalk, English, light	lb.	.05	— .06
Chalk, English, dense	lb.	.04½	— .05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00	— 10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00	— 15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00	— 22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00	— 40.00
China clay (kaolin), imported, lump	net ton	23.00	— 25.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00	— 14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50	— 10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	— 23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	— 21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	— 21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	— 30.00
Fullers earth, f.o.b. Mines	net ton	16.00	— 17.00
Fullers earth, granular, f.o.b. Fla.	net ton	25.00	— .....
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	— .....
Fullers earth, imported, powdered	net ton	35.00	— 40.00
Graphite, crucible, 90% carbon, Ashland, Ala.	lb.	.....	— .09
Graphite, crucible, 85% carbon, Ashland, Ala.	lb.	.07	— .09
Graphite, higher lubricating grades	lb.	.11	— .40
Pumice stone, imported, lump	lb.	.04	— .50
Pumice stone, domestic lump	lb.	.05	— .05½
Pumice stone, ground	lb.	.06	— .07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.....	— 10.00
Quartz (acid tower) 1¼@2 in., f.o.b. Baltimore	net ton	.....	— 14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.....	— 17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	— 7.50
Shellac, orange fine	lb.	.65	— .....
Shellac, orange superfine	lb.	.70	— .....
Shellac, A. C. garnet	lb.	.57	— .....
Shellac, T. N.	lb.	.55	— .....
Soapstone	ton	12.00	— 15.00
Sodium chloride	long ton	14.00	— 15.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00	— 22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50	— 15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00	— 18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	— 15.00
Talc, imported	ton	40.00	— 50.00
Talc, California talcum powder grade	ton	20.00	— 45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	80-100
Chrome cement, 40-45% Cr_2O_3	net ton	45- 50
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	....- 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55- 60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45- 50
Magnesite brick, 9-in. straight	net ton	100
Magnesite brick, 9-in. arches, wedges and keys	net ton	105
Magnesite brick, soaps and splits	net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65- 70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56- 61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	50- 60

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.16 —	...
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	95.00 —	100.00
Ferromanganese, 76-80% Mn, English	gross ton	95.00 —	100.00
Spiegeleisen, 18-22% Mn	gross ton	38.00 —	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.50
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	90.00 —	95.00
Ferrosilicon, 75%	gross ton	150.00 —	155.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.55 —	.60
Ferrouranium, 35-50% of U, per lb. of U content	lb.	7.00 —	......
Ferrovanadium, 30-40% per lb. of contained V	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.55 —	.60
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	.50 —	.55
Coke, foundry, f.o.b. ovens	net ton	6.00 —	6.50
Coke, furnace, f.o.b. ovens	net ton	5.00 —	5.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	16.00 —	17.00
Fluorspar, lump, f.o.b. Heathden, New Mexico	net ton	17.50 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50 —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.40 —	.45
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	......
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.16 —	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.16½—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.00 —	3.25
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	.....
Zircon, washed, iron free	lb.	.03 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.50
Aluminum, 98 to 99 per cent	28.3@28.5
Antimony, wholesale lots, Chinese and Japanese	5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35
Monel metal ingots	38
Monel metal, sheet bars	40
Tin, 5-ton lots	29.25
Lead, New York, spot	3.75@4.00
Lead, E. St. Louis, spot	3.75@4.00
Zinc, spot, New York	7.00
Zinc, spot, E. St. Louis	4.75

OTHER METALS

Silver (commercial)	oz.	$0.54
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	1.45
Cobalt	lb.	4.50
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	70.00
Iridium	oz.	300.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.25
Copper bottoms	33.00
Copper rods	28.00
High brass wire and sheets	18.75
High brass rods	16.75
Low brass wire and sheets	27.50
Low brass rods	18.50
Brazed brass tubing	35.25
Brazed bronze tubing	40.50
Seamless copper tubing	25.00
Seamless high brass tubing	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	11.50	18.50	10.00	10.50
Copper, heavy and wire	11.00	16.50	9.50	9.50
Copper, light and bottoms	9.00	14.50	9.00	8.50
Lead, heavy	4.00	7.25	4.00	4.00
Lead, tea	3.00	5.25	3.00	3.00
Brass, heavy	7.00	9.50	7.00	10.00
Brass, light	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings	6.00	9.50	5.50	6.00
Zinc	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3.73	$3.80	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands	4.33	4.65	4.22	6.25	....	....	....
Plates, ¼ to 1 in. thick	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MONTGOMERY—The Jenkins Brick Co. has plans under way for extensions and improvements in its plant. The present kiln capacity will be increased, and corresponding enlargements made in other departments. New machinery will be installed, including pulverizing and other equipment.

Arkansas

HOPE—The Arkansas-Texas Oil Co. is considering plans for the construction of a new oil refinery on a local site. A pipe line extending to the oilfields will be installed. W. T. Knight is president.

California

RICHMOND—The Natural Soap Co., with headquarters at San Marcial, N. M., is negotiating with the local Chamber of Commerce for a site for the erection of a new plant. It is said that the proposed factory will cost in excess of $50,000.

EL SEGUNDO—The General Chemical Co., Los Angeles, is planning for the early operation of its new acid-manufacturing plant here, now in course of erection. The plant consists of four units, and each will be placed in service as soon as completed.

Connecticut

BETHEL—The D. J. Lane Leather Co. is completing plans for the rebuilding of its local plant, recently destroyed by fire. One large plant unit will be constructed on the same site as previously used for a number of smaller buildings. As soon as the new factory is completed, the company will remove its present branch works at Danbury to the Bethel location.

WATERBURY—The Scovill Mfg. Co., Bridge St., manufacturer of brass and other metal goods, will soon commence the erection of a new 1-story brass mill, 155 x 160 ft., brick and steel, estimated to cost about $100,000 with equipment. Hugh L. Thompson, 57 North Main St., is engineer.

Delaware

WILMINGTON—The Wilmington Leather Co. is adjusting matters regarding insurance on the recent fire at its plant at Second and Greenhill Sts., and has preliminary plans under way for the rebuilding of the works, replacing a fire damage estimated at $1,000,000 with machinery. The reports that the plant would not be rebuilt have been denied. James J. O'Neill is president.

Georgia

HAZLEHURST—The Carter Cotton Oil Co. is planning for the rebuilding of its plant, destroyed by fire Feb. 19, with loss estimated at $100,000, including equipment.

Illinois

CHICAGO — The American Insulated Wire & Cable Co. will locate a copper wire rod mill here. It has purchased property at the northwest corner of Twenty-second and Fisk Sts., which is at present occupied by a 1-story plant. This plant will be remodeled at a cost of about $100,000. Additional equipment to be installed will cost about $200,000.

CHICAGO—The American Cereal Products Co. of Chicago has acquired the plant of the Acme Malting Co., at the northwest corner of Bloomingdale Rd. and Kedvale Ave. Alterations in this plant and purchase of new equipment is contemplated.

CHICAGO—The Goodman Mfg. Co. producer of mining machinery and supplies, electric locomotives, etc., has acquired new property at the northwest corner of Halstead and Forty-Eighth Sts., anticipating enlarged facilities due to future growth of business.

LYONS—The University Oil Products Co., 208 South La Salle St., Chicago, has commenced the erection of its proposed new local oil plant. The refining works will consist of five 1- and 3-story plant units, totaling 50 x 1,000 ft. in size. Holabird & Roche, 104 South Michigan Ave., Chicago, are architects. H. J. Halls is president.

CHICAGO—The Mid-West Box Co. of Delaware has been organized with a capital of $7,500,000 to take over the plants and business of the Mid-West Box Co. of Indiana, 111 West Washington St., Chicago; Mid-West Box Co. of Ohio; the Mid-West Box Co. of West Virginia, and the American Straw Board Co., Akron, O. The first noted companies specialize in the manufacture of corrugated fiber shipping cases, containers and other products, and the acquisition of the American Straw Board interests is to secure a definite supply of raw materials. Expansion plans are under way at a number of the plants of the combined company, and increased output will be arranged.

Kentucky

BOWLING GREEN—The American Producing & Refining Co. has plans under way for the erection of a new oil-refining plant, with initial capacity of about 1,000 bbl. per day. It is estimated to cost close to $200,000 with machinery.

Louisiana

MONROE—The American Carbon Co., recently organized with a capital of $1,500,000 by interests connected with the Southern Carbon Co., has plans under way for the erection of a new local plant for the manufacture of carbon from lignite under a special process. The new carbon, it is said, will be used primarily in refining sugar, replacing the bone black now employed. The plant with machinery is estimated to cost in excess of $750,000.

Maryland

BALTIMORE — The United States Industrial Chemical Co., Curtis Bay, has filed plans for the erection of a 1-story plant addition, 60 x 180 ft., to cost about $14,000.

BALTIMORE—Frank G. Kitchen has leased a building at Hollins St. and Calverton Rd., adjoining the factory of the Lipps Candy Co. and previously used in connection with this business, for the establishment of a new plant for the manufacture of varnishes, stains, oils and kindred specialties. Equipment for this purpose will be installed at once.

CANTON—The Standard Oil Co. has acquired a large tract of land adjoining its local plant, heretofore held by the Canton Co., and will use the property for proposed future additions. No announcement has been made as to time of erection. The company has also taken title to a number of pieces of property on First St., Baltimore, for use in connection with its new terminal at this location.

CUMBERLAND—The American Cellulose & Chemical Co. is planning for operations at its new local plant early in the summer. The different structures are now nearing completion, forming the initial units, and machinery will be installed promptly. This section of the plant is said to represent an investment of $4,000,000. The entire project as planned, covering additional manufacturing units, will cost in excess of $8,000,000.

Massachusetts

FRAMINGHAM—The Dennison Mfg. Co., manufacturer of paper specialties, has plans under way for a new 4-story addition, 70 x 100 ft. Monks & Johnson, 99 Chauncey St., Boston, are architects.

Minnesota

MINNEAPOLIS — The Hannepin Atomized Fuel Co., 500 Security Bldg., is having plans prepared for the construction of a new 1-story fuel-crushing plant at St. Paul. The works will cost about $150,000 with machinery. C. L. Pillsbury, 1206 Second Ave., is engineer.

Missouri

KANSAS CITY—The Corn Products Refining Co., 17 Battery Pl., New York, has construction well under way on its new plant at North Kansas City, and will place the work in service at an early date. Miscellaneous contracts for completion work have been let. The plant will consist of three complete units, and represents an investment of about $7,000,000.

New Jersey

NEWARK—G. N. Bick has filed plans for the erection of a new plant at 71-75 Paris St., to be 42 x 62 ft., for the manufacture of chemicals. The factory will include a laboratory.

BAYONNE—The International Nickel Co. has filed plans for the erection of a number of 1-story buildings at its plant at the foot of Twenty-second St., to cost about $18,000.

BLOOMINGDALE — Lissberger Bros., operating the Somerville Iron Works, Somerville, N. J.; the Eagle Smelting & Refining Works, Newark, and other industries in the state, have leased the former plant of the Morris County Chemical Co., East Bloomingdale, for the establishment of a chemical, dye and affiliated products experimental plant. Operations will be inaugurated at once under the direction of Dr. S. A. Molnar, chemical engineer. The plant was at one time occupied by the Butler Chemical Co., now defunct, and later, by the New Jersey Chemical Co.

NEWARK—In addition to its proposed new plant at Beaufort, S. C., recently announced, the Ocean Leather Co., Inc., 33 New York Ave., is planning for the establishment of a similar factory for the treatment of shark skins at Hyannisport, in this same vicinity. It is said that the plant will be one of the largest of the company's works, and will be equipped for all features of fish leather production. It will be operated on an all-year basis.

New York

BUFFALO—The University of Buffalo has filed plans for the erection of a new 3-story chemistry building at Main St. and Niagara Falls Blvd. It is estimated to cost about $400,000. A large laboratory will be installed.

Ohio

CAREY—The Hume China Co. is completing plans for the construction of a new 1-story pottery, 150 x 500 ft., and will soon call for bids. It will be of brick, tile and concrete. W. W. Matchett, 408 Alliance Bank Bldg., Alliance, O., is architect. George H. Hume is president.

SANDUSKY—The Hinde & Dauch Paper Co., manufacturer of corrugated fiber boxes, containers, etc., is having plans prepared for the erection of its proposed new paper mill and factory at Fort Madison, Ia. The plant will be about 100 x 340 ft., and with machinery is estimated to cost close to $1,000,000. The Ferguson Co., Columbus, O., is engineer and architect.

DOVER—The Dover Coke & By-Products Co. is arranging for the immediate construction of four additional ovens at its plant. Improvements will be made in a number of present oven units at the works.

Pennsylvania

PHILADELPHIA—The Gulf Refining Co., 21 State St., New York, and Pittsburgh, Pa., has abandoned plans temporarily for its proposed new oil refinery to be located at Girard Point, Philadelphia. The company acquired a tract of about 70 acres of land some time ago at this location and has done considerable preliminary work, including the construction of a reinforced-concrete wharf, 55 x 840 ft. The company is now operating a local plant at Fifty-eighth St. and the Schuylkill River.

South Carolina

COLUMBIA—The H-W Chemical Co., recently organized, is planning for the establishment of a local factory for the manufacture of chemicals and affiliated products. A local building has been secured and equipment will be installed at once. The company is headed by J. S. Hammack and J. W. Wilson.

CHESNEE—The Crawley Gin Co., recently organized, will operate a local cottonseed oil mill. T. A. Sawyer is president, and John B. Cash, secretary and treasurer.

Texas

SWEETWATER—The Sweetwater Refining Co. has acquired a local site and has plans under way for the construction of a new oil refinery.

LINDEN—The Pratt Bros. Iron Ore Development Co., Minneapolis, Minn., has commenced preliminary work on its proposed new ore-crushing plant at Bowieville, near Linden. The works will comprise departments for crushing, screening and roasting, with initial equipment to provide for a capacity of about 400 tons per day. At a

later date it is proposed to install a magnetic process plant for ore treatment, supplanting the roasting method. The company's holdings in this district are estimated to contain about 6,000,000 tons of ore.

BURKBURNETT—The C. F. Noble Oil & Gas Co. is planning for the rebuilding of the portion of its local gasoline plant, recently destroyed by fire with loss reported at about $18,000.

Washington

CENTRALIA—The Steel Casting Co. has been incorporated by officials of the Tennent Steel Casting Co., Tacoma, Wash., with a capital of $75,000, to operate a local plant. Plans are being perfected for the new works, to be equipped for the production of high-grade steel castings.

New Companies

THE KEMIKO Co., Newark, N. J., has been incorporated with a capital of $50,000 to manufacture chemicals. The incorporators are Adelbert L. Vandenburg, Harold W. Yapp, and Henry Faust, 112 South Seventh Street.

LOMBARD & Co., INC., Boston, Mass., has been incorporated with a capital of $350,000 to manufacture grinding wheels, abrasive materials and kindred products. The incorporators are John H. McGill, Walter L. and William H. McGill, 21 Oxford Street, Winchester, Mass.

THE SPECIAL PRODUCTS Co., Hopewell, Va., has been incorporated with a capital of $250,000 to manufacture paints, varnishes and affiliated products. The incorporators are J. C. Fleming and Clay Littleton.

THE WICOMICO FARMERS' ASSOCIATION, Salisbury, Md., has been incorporated with a capital of $50,000 to establish and operate a fertilizer manufacturing plant under co-operative plans. The incorporators are William C. Mitchell, E. Dale Atkins, and William M. Cooper, Salisbury.

YARDLEY & Co., LTD., New York, has been incorporated with a capital of $100,000 to manufacture soap and affiliated products. The incorporators are C. Smith, R. E. Gardner and L. M. Townsend, 48 Wall Street.

THE ROFF COTTON OIL Co., Ada, Okla., has been incorporated with a capital of $50,000 to manufacture cotton oil products. The incorporators are P. A. Norris and C. L. Griffith, Ada; and W. R. Brents, Sherman, Tex.

THE MIDDLETON & PETERSON Co., Savannah, Ga., has been incorporated with a capital of $30,000 to manufacture cotton oil products and kindred specialties. The incorporators are M. L. Middleton, and W. M. Peterson.

THE AMERICAN CARBON Co., Monroe, La., has been incorporated with a capital of $1,500,000 to manufacture carbon products. The incorporators are M. C. Redmond, and Earl P. Hartshorne, Monroe.

THE UNION STONEWARE Co., 400 West Kinzie St., Chicago, Ill., has been incorporated with a capital of $50,000 to manufacture glass, pottery, porcelain and other ceramic products. The incorporators are W. P. White, E. S. Hoyt and W. H. Putnam.

THE LIMESTONE PRODUCTS Co., Black Rock, Ark., has been incorporated with a capital of $400,000 to manufacture hydrated lime and other lime products. The incorporators are William H. Woodruff, Jonesboro, Ark.; C. E. Scott and D. S. Alessi, Springfield, Mo.

THE SPANISH MOSAIC TILE Co., Washington, D. C., has been incorporated under Delaware laws with a capital of $25,000 to manufacture floor and wall tile, mosaics, etc. The incorporators are M. A. Cahill, Redick W. Ridgely and William A. McGuire, Washington.

THE AMERICAN FIBER CONDUIT CORP., Fulton, N. Y., has been incorporated with a capital of $350,000 to manufacture fiber conduits and other fiber products. The incorporators are G. M. Fanning, G. Crossman and R. F. Freeman, Fulton.

DOE & INGALLS, INC., Boston, Mass., has been incorporated with a capital of $100,000 to manufacture chemicals and chemical byproducts. The incorporators are Robert C. Ingalls, Charles E. Haywood and Willis H. Doe, 236 Milk St.

THE VEREX CHEMICAL Co., Lakewood, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemical products. The incorporators are Lester H. Sparks, Arthur R. Smock and William J. Norton, Lakewood.

THE M. & M. MFG. Co., Tipton, Ind., has been incorporated with a capital of $10,000 to manufacture chemicals and chemical byproducts. The incorporators are E. L. and T. M. Mitchell, and J. W. Meader, Tipton.

THE DUNBAR OIL Co., 43 East Ohio St., Chicago, Ill., has been incorporated with a capital of $100,000 to manufacture refined oil products. The incorporators are J. O. Karstrom, E. W. Spicer and R. B. Kee.

THE KARVA LABORATORIES, INC., New York, has been incorporated with a capital of $15,000 to manufacture chemicals and affiliated products. The incorporators are J. Schron, L. L. Leventritt and R. S. Mazzola, 128 Broadway.

THE PENNSYLVANIA METAL REDUCTION Co., Pittsburgh, Pa., has been incorporated with a capital of $10,000 to operate a metal-refining plant. E. F. Straw, Pittsburgh, is treasurer.

THE ALLIED RUBBER COMPANIES, INC., Calvart Bldg., Baltimore, Md., has been incorporated with a capital of 500,000 shares of stock, no par value, to manufacture rubber products, gutta percha specialties, etc. The incorporators are William Leary, James A. Curtis and Leslie E. Mihm.

THE PARKER RUBBER MFG. Co., Boston, Mass., has been incorporated with a capital of $125,000 to manufacture rubber goods. The incorporators are David H. Finberg, Philip Finberg, and Harry D. Finberg, 621 Albany St.

KEINER & Co., Newark, N. J., have been incorporated with a capital of $125,000 to manufacture chemical products. The incorporators are Erich G. Keiner, Wilmington, Mass.; Irving Willner and Jacob Lubetkin, Newark.

THE DUQUESNE SHEET GLASS Co., Pittsburgh, Pa., has been incorporated undar Delaware laws with capital of $100,000 to manufacture sheet glass specialties. The incorporators are Thomas H. Chadwick, Pittsburgh; George W. Fees, Arnold, Pa.; and John A. Wilson, Wilkinsburg, Pa.

THE IMPERIAL JAPANNING & ENAMELING WORKS, INC., 408 West Grand Ave., Chicago, Ill., has been incorporated with a capital of $100,000 to manufacture enameled products, japanned goods, etc. The incorporators are John A. Skailand, Joseph V. Janda and William Link.

THE RICHFIELD GRANT OIL Co., Los Angeles, Cal., has been incorporated with a capital of $1,500,000 to manufacture petroleum products. The incorporators are W. J. Honam, Los Angeles; J. E. Michel, Corcoran, Cal.; A. W. Miller, Riverside, Cal.

THE TAYLOR RUBBER Co., Detroit, Mich., has been incorporated with a capital of $1,000,000 to manufacture rubber products. The incorporators are Hugh Thorburn, 510 Newport Ave., Detroit; and Parker G. Ballon, Rathborn, Ont.

THE McLAIN OIL CORP., New York, has been incorporated with a capital of $175,000 to manufacture refined oil products. The incorporators are J. D. Martensen, C. W. Osborne and J. F. Renfro, 212 West 68th St.

THE EXCHANGE CHEMICAL Co., Bangor, Me., has been incorporated with a capital of $50,000 to manufacture chemicals and byproducts. The incorporators are Julius Byer, Moses L. Friedman and Max S. Kominsky, Bangor.

THE AMERICAN APPARATUS GLASS Co., Vineland, N. J., has been organized to manufacture scientific laboratory glassware. The company is headed by S. A. Giederoye, president; W. Shewell Hood, vice-president and general manager; and Otto Lind, treasurer and superintendent.

THE KENTUCKY SHALE PRODUCTS Co., Bardstown, Ky., has been organized to manufacture brick and other burned clay products. The company is headed by J. B. Beam, L. B. Samuel and J. A. Fulton, Bardstown.

THE NEW PROCESS METAL CORP., Newark, N. J., has been incorporated with a capital of $250,000 to manufacture refined metals and metal alloys. The incorporators are Walter F. Young, Newark; Sydney T. Edge, West Paterson; and Frank J. Morris, West Orange, N. J.

THE CHRISTENSEN & OLSEN FOUNDRY Co., 1713 Carroll Ave., Chicago, Ill., has been incorporated with a capital of $5,000 to manufacture aluminum, brass and bronze castings, etc. The incorporators are Arthur O. Olsen and S. L. Christensen.

THE SUPERIOR PRODUCTS Co., Cortland, N. Y., has been incorporated with a capital of $15,000 to manufacture paint and kindred products. The incorporators are A. A. Loomis, C. M. Smith and C. R. Hall, Cortland.

Capital Increases, Etc.

THE TEXAS Co., 17 Battery Pl., New York, operating oil refineries at various points in Texas, has arranged for an increase in capital from $130,000,000 to $143,000,000.

THE MICHIGAN PAPER Co., Plainwell, Mich., has increased its capital from $1,000,000 to $3,000,000 for expansion.

THE NOXON CHEMICAL PRODUCTS Co., 22 Hackett St., Newark, N. J., has filed notice of increase in capital from $150,000 to $325,000 for general operations, expansion, etc.

THE CHEMICALS INDUSTRIALS CORP., New York, has filed notice of increase in capital from $29,000,000 to $33,000,000 for proposed extensions.

THE SIMPSON CLARK GLASS Co., 164 West Randolph St., Chicago, Ill., has filed notice of increase in capital from $75,000 to $100,000.

THE GEORGE STRATFORD OAKUM Co., Cornelison Ave., Jersey City, N. J., manufacturer of marine oakum, etc., has filed notice of increase in capital from $60,000 to $500,000 for proposed expansion.

THE CHEMICAL RESEARCH Co. OF AMERICA, Boston, Mass., has filed notice of change of name to Korite Products, Inc., to manufacture chemical specialties.

THE GILMAN PAINT & VARNISH Co., Chattanooga, Tenn., manufacturer of paints, oils, varnishes, etc., has increased its capital to $75,000. W. D. Gilman is president.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

REFRACTORIES MANUFACTURING ASSOCIATION will hold a meeting at the Hotel Pennsylvania, New York City, March 17 to 19.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society